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Scientific Highlights/Abstracts of Original Investigations

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SLEEP

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This abstract supplement unites *SLEEP* and the science of the SLEEP 2014, the 28th Annual Meeting of the Associated Professional Sleep Societies, LLC (APSS), and provides a glimpse into the most current ideas and latest research taking place in the field of sleep.

All abstracts presented at SLEEP 2014 held May 31 – June 4, 2014, in Minneapolis, Minnesota are included in this special issue. This year, 1,096 abstracts will be presented at the meeting. 196 will be presented in an oral presentation format, and the remainder will be presented in a poster format. In addition, individuals in training programs will be presenting posters of case reports, which are contained in the supplement, and abstracts, which, although not included in this supplement, will be an exciting portion of the meeting.

The abstracts are divided between basic and clinical sleep science and then assigned to one of 27 subcategories. Each abstract has a unique four-digit number to facilitate identification and location both within this issue and at SLEEP 2014. The four-digit number in the abstract supplement matches the four-digit code published in the SLEEP 2014 Final Program.

The SLEEP meeting fosters an environment in which members and attendees obtain education on the latest basic science, clinical science and technologies, which will further promote the continued growth of the field through the dissemination of new knowledge. We look forward to sharing in the success of this pivotal event.

David F. Dinges, PhD
Editor-in-Chief

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0001

SLEEP PROMOTION BY DUAL AND NOVEL SELECTIVE OREXIN RECEPTOR ANTAGONISTS IN GENETIC MODELS SUGGEST ROLES FOR OX1R AND OX2R IN SLEEP REGULATION

Gotter AL¹, Stevens J², Garson SL², Harrell CM², Tannenbaum PL², Yao L², Kuduk SD², Coleman PJ², Renger JJ², Winrow CJ²

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Introduction: Orexin neuropeptides signal through orexin 1 and 2 receptors (OX1R, OX2R) to promote arousal and regulate vigilance state progression. Blockade of both receptors by dual orexin receptor antagonists (DORAs) in preclinical and clinical studies promotes sleep onset, maintenance and efficiency. Novel OX2R selective antagonists (2-SORAs), however, are also capable of promoting sleep both preclinically and clinically. OX2R is thought to mediate arousal through hypothalamic histaminergic signaling while the contribution of OX1R and OX2R to vigilance state regulation is unclear.

Methods: The contribution of OX1R and OX2R to sleep regulation was evaluated by polysomnography in wildtype mice and OX2R knockouts following DORA, 2-SORA or 1-SORA treatment. Dose-dependent OX2R occupancy of DORAs and 2-SORAs was evaluated in transgenic rats expressing hOX2R. Histamine changes were evaluated in rat hypothalamus and prefrontal cortex by microdialysis. FECT (food elicited cataplexy test) was used to evaluate cataplexy potential of DORA-12 and MK-1064 in canines.

Results: DORAs attenuate arousal primarily through OX2R, since effects on active wake and most sleep measures are nearly absent in OX2R knockout animals. Both DORAs and 2-SORAs attenuate histamine, a primary promoter of cortical arousal. The OX1R contribution to DORA activity measurably promotes REM sleep and sleep stage entries as revealed in knockout models and cross-species evaluation of DORAs, 2-SORAs and 1-SORAs on sleep architecture. Evaluation of over 6 different compounds indicates 2-SORAs require greater OX2R occupancy relative to DORAs in order to achieve active wake reduction, REM sleep promotion and reduced latency to persistent sleep. FECT analysis of DORA-12 and the novel 2-SORA, MK-1064, elicited no cataplexy at doses > 30-fold that needed for sleep promotion.

Conclusion: While both DORAs and 2-SORAs similarly promote sleep, DORAs have a greater capacity to attenuate active wake, promote REM sleep and decrease latency to persistent sleep with no apparent cataplexy potential in preclinical models.

Support (If Any): This research was funded by Merck & Co., Inc.

0002

PRECLINICAL PHARMACOLOGICAL CHARACTERIZATION OF E2006, A NOVEL DUAL OREXIN RECEPTOR ANTAGONIST FOR INSOMNIA TREATMENT

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Introduction: Dual orexin receptor antagonists (DORA) promote sleep in animals and humans, offering a new treatment option for insomnia patients. Here we describe in vitro and initial in vivo characterization of the novel DORA E2006.

Methods: In vitro characterization of E2006 included receptor binding assay (RBA), off-target assay, kinetic RBA with human orexin-2 receptor (hOX2R)-selective antagonist EMPA as surrogate tracer, and a cell-based functional assay. In vivo evaluations of orally applied E2006 started with functional tests in rats using OX2R-transmitted increase in plasma adrenocorticotrophic hormone. Mouse locomotion was measured for 1 hour after dosing at CT5. Sleep/wake behavior was determined via EEG/EMG for 3 hours after dosing at CT4. Almorexant and zolpidem were used as comparators.

Results: IC₅₀ values of E2006 on human orexin-1 receptor (hOX1R) and hOX2R are 6.1 and 2.6 nmol/L, respectively. Among 88 off-targets, E2006 interacted only with human melatonin 1 receptor as a weak antagonist (K_i 922 nmol/L). E2006 displayed fast-on and fast-off binding kinetics on the hOX2R, indicating potential for fast onset of action and reduced risk of next-morning drowsiness. E2006 is a competitive antagonist, with K_i values of 14.1 and 0.391 nmol/L for hOX1R and hOX2R, respectively, and binds to hOX2R in an orthosteric fashion. From 3 mg/kg on, E2006 dose-dependently counteracted the OX2R-selective [Ala¹¹, D-Leu¹⁵]-orexin-B-induced increase in plasma adrenocorticotrophic hormone concentration. At doses of 30 and 100 mg/kg, E2006 significantly decreased locomotion of wild-type mice, while it had no effect on orexin-neuron deficient orexin/ataxin-3 Tg/+ mice. In mice, 10 mg/kg E2006 significantly increased non-REM and REM sleep time in a ratio of about 3:1, without changing composition of promoted sleep, as judged by REM sleep time ratio to total sleep time.

Conclusion: E2006 has been preclinically demonstrated to be a potential novel therapeutic for the treatment of insomnia.

Support (If Any): All authors are employees of Eisai Co., Ltd., Japan.

0003

E2006, A NOVEL DUAL OREXIN RECEPTOR ANTAGONIST PROMOTES PHYSIOLOGICAL SLEEP IN MICE AND RATS WITHOUT CAUSING MOTOR IMPAIRMENT OR ALCOHOL INTERACTION

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Introduction: As clinical candidate for insomnia treatment, we describe the preclinical characterization of novel dual orexin receptor antagonist E2006 in regard to rodent sleep and some safety pharmacology aspects.

Methods: Electroencephalogram and electromyogram signals were collected via brain and neck electrodes during light period. Rats received acutely 3-300 mg/kg E2006 and were also treated once daily with 30 mg/kg E2006 for 3 weeks to investigate tolerance and discontinuation effects. Mice were acutely dosed with 0.1-3 mg/kg (wildtype) E2006 or 30 mg/kg (orexin neuron-deficient), and were additionally assessed for motor coordination (Rotarod) and ethanol-induced anesthesia under up to 300 mg/kg E2006. Zolpidem and almorexant were used as comparators where applicable.

Results: In rats, the ED₅₀ of oral E2006 for dose-dependent increase in total sleep time was 4.4 mg/kg, without changing REM sleep ratio and therefore indicating physiological sleep, in contrast to zolpidem, which suppressed REM sleep. When rats were chronically treated with E2006, sleep time-increasing effect and reduction of sleep latency were constant, indicating neither tolerance nor sensitization. Upon discontinuation, sleep returned to pre-dosing values without rebound, different from zolpidem. In acute and chronic rat experiments, no direct transition from wakefulness to REM sleep was observed. In mice, oral E2006 increased total sleep time from 1 mg/kg on without influence on REM sleep ratio, and reduced sleep latency. 30 mg/kg almorexant and 3 mg/kg zolpidem also promoted sleep with comparable effect sizes. E2006 did not promote sleep in orexin-neuron deficient mice. Up to 300 mg/

kg, oral E2006 in mice did not impair motor coordination nor did it significantly interact with ethanol, while 100 mg/kg zolpidem showed clear detrimental effects.

Conclusion: We expect E2006 to promote physiological sleep in humans without impairing motor coordination or showing a strong interaction with alcohol, offering potential advantages over non-benzodiazepine gaba-ergics.

Support (If Any): All authors are employees of Eisai Co., Ltd., Japan.

0004

GAL-160, A NOVEL ORALLY BIOAVAILABLE MODULATOR OF BREATHING CONTROL, DECREASES THE SEVERITY OF OBSTRUCTIVE APNEAS IN RATS

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Introduction: GAL-160 is a novel orally bioavailable drug in development to treat sleep disordered breathing. Here, we describe the effects of GAL-160 in a model of obstructive apnea (OA) in rats.

Methods: Minute volume, breathing pattern, esophageal pressure, arterial blood pressure, pulse rate, and transcutaneous pulse oximetry were recorded continuously from urethane anesthetized supine rats which display manifestations of OA. In the first study, in order to validate the model, we evaluated the dose-response relationship for the effects of continuous positive airway pressure (CPAP, 0.5 to 4 cmH₂O) on OA severity. In the second study, GAL-160 was administered by intravenous infusion for 75 minutes at two doses: higher dose (HD) - 0.010 mg/kg/min loading for 15 minutes then 0.006 mg/kg/min maintenance for 60 minutes; lower dose (LD) - 0.005 mg/kg/min loading for 15 minutes then 0.003 mg/kg/min maintenance for 60 minutes. In the final study, genioglossus and diaphragm EMG activities were recorded during standardized 5- and 10-second tracheal obstructions in urethane anesthetized rats before and during HD GAL-160 infusion.

Results: CPAP dose-dependently decreased OA severity with a maximal effect at 4 cmH₂O. GAL-160 dose-dependently decreased OA frequency (baseline 30 ± 4 /hr, HD infusion: 10 ± 3 /hr), OA length (baseline 11 ± 1 s, HD infusion: 5 ± 1 s), and the drop in SpO₂ during residual apneas (baseline -20 ± 2 %, HD infusion: -9 ± 2 %) compared to pre-drug baseline and vehicle controls. The minimally effective plasma concentration of GAL-160 was ~40 ng/mL. GAL-160 had minimal effects on minute volume, mean arterial blood pressure and pulse rate. GAL-160 (HD) increased genioglossus, but not diaphragm, EMG activity during standardized tracheal obstructions.

Conclusion: These data demonstrate that GAL-160 attenuates OA in rats and this effect may be due, in part, to increased recruitment of the genioglossus muscle during spontaneous obstructions.

0005

GAL-160, A NOVEL ORALLY BIOAVAILABLE MODULATOR OF BREATHING CONTROL, ATTENUATES CENTRAL SLEEP APNEA IN RATS RECEIVING CHRONIC MORPHINE

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Introduction: GAL-160 is a novel orally bioavailable drug in development as a therapeutic agent for the treatment of sleep disordered breathing. Here we describe the effects of GAL-160 on central sleep apnea (CSA) frequency and sleep architecture in rats receiving morphine chronically.

Methods: Non-restrained lean Zucker male rats were administered morphine (0.9 mg/mL) continuously in their drinking water for at least 14

days to increase the frequency of spontaneous CSA. In the first study, breathing was measured using whole-body plethysmography and dose range finding experiments were performed to determine the maximally effective dose (ED_{max}) of GAL-160 (3, 7, and 15 mg/kg PO) at decreasing the frequency of CSA during subjective sleep (i.e., eyes closed and recumbent). In the second study, similar rats were implanted with EEG/EMG telemeters to permit sleep scoring into 4 second epochs of NREM/REM/AWAKE before and after oral gavage of the ED_{max} of GAL-160 or vehicle. In a separate cohort of rats, the pharmacokinetic profiles of GAL-160 (3 and 7 mg/kg PO) were characterized. Data are expressed as means ± SEM.

Results: In non-telemeterized rats, GAL-160 dose-dependently decreased CSA frequency compared to the pre-drug baseline and vehicle controls. The ED_{max} of GAL-160 was 7 mg/kg PO, which decreased CSA frequency from 15 ± 3 /hr to 3 ± 2 /hr (p < 0.05). In telemeterized rats, GAL-160 (7 mg/kg, PO) selectively decreased CSA during NREM sleep with no effect on minute volume, sleep architecture, or NREM/REM spectral power density or relative power compared to the pre-drug baseline and vehicle controls. The minimally effective plasma concentration of GAL-160 in the 7 mg/kg dose group was determined to be 40 ng/mL.

Conclusion: These data demonstrate that oral GAL-160 reduces CSA frequency during NREM sleep without altering breathing pattern or sleep architecture in rats receiving chronic morphine.

Support (If Any): Galleon Pharmaceuticals.

0006

INTERMITTENT-HYPOXIA-INDUCED EXPRESSION OF AUTOPHAGY ACCELERATES BNIP3 IN THE GENIOHYOID MUSCLE IN CONTRAST TO GASTROCNEMIUS MUSCLE IN RATS

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Introduction: Intermittent hypoxia (IH) is a major component of obstructive sleep apnea syndrome (OSAS). Patients with OSAS showed fatigued or inefficient upper airway dilation due to upper-airway neuromuscular abnormalities and muscular fiber atrophy induced by repetitive exposure to IH. The geniohyoid muscle is one of the major contributors to airway patency by moving the hyoid bone forward. IH causes hypoxia-induced autophagy in muscle cells through hypoxia-inducible factor (HIF) induction of BH3-only proapoptotic protein (BNIP3), which is associated with muscle atrophy. However, little is known about molecular mechanisms of muscle atrophy and dysfunction in the geniohyoid muscle induced by IH. The purpose of this study was to elucidate metabolic responses of the geniohyoid muscle in IH-exposed rats.

Methods: Seven-week-old Sprague-Dawley male rats were exposed to IH at a rate of 20 cycles/h (nadir of 4% O₂ to peak of 21% O₂ with 0% CO₂) or normal air (control) for 8 h/d for 3 weeks. After the experimental period, qPCR and immunoblots of the geniohyoid muscle were performed for HIFs, BNIP3, and PGC-1, which serve a pivotal role in skeletal muscle metabolism and function. The gastrocnemius muscle was also obtained and analyzed as a reference. Data were statistically assessed using a Mann-Whitney U test (P < 0.05).

Results: Immunoblots showed that exposure to IH for both 4 day and 3 week significantly elevated HIF-1α protein level in the geniohyoid muscle, whereas HIF-1α protein level did not significantly change

in gastrocnemius muscles. BNIP3 protein expression significantly increased in the geniohyoid muscle after 3 week of IH exposure, not in the gastrocnemius muscle. PGC-1 mRNA level was significantly decreased in the geniohyoid muscle after 4 day and 3 week, whereas it was not affected in the gastrocnemius muscle.

Conclusion: Results suggest the possibility of IH-induced autophagy and dysfunction in the geniohyoid muscle through BNIP3 expression.

0007

OREXIN-1 RECEPTOR BLOCKADE DYSREGULATES REM SLEEP IN PHARMACOLOGICAL OR GENETIC MODELS OF OREXIN-2 RECEPTOR INHIBITION

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Introduction: Dual orexin-1/orexin-2 receptor (OX1/2R) or selective OX2R antagonists have been shown to promote sleep in various species. While selective blockade of OX2R seems to be sufficient to initiate and prolong sleep, the beneficial effect of additional inhibition of OX1R remains controversial. We further explored the respective contribution of OX1R and OX2R on sleep-promoting effects elicited by blockade of both receptors, and specifically on REM sleep since orexin deficiency is associated with narcolepsy/cataplexy.

Methods: Rats received the dual OX1/2R antagonist SB-649868 (10 and 30 mg/kg po) or the OX1R antagonist GSK-1059865 (10 mg/kg sc) in combination with the OX2R antagonist JNJ-10397049 (10 mg/kg sc) at dark onset. OX2R KO and WT mice were orally dosed with an OX1R antagonist (compound A, 30 mg/kg) at 2 h into light phase.

Results: In rats, SB-649868 promoted both NREM and REM sleep. However, a disruption of REM sleep was evidenced by a more pronounced reduction in the onset of REM as compared to NREM sleep, a marked enhancement of the REM/total sleep ratio and episodes of direct wake to REM sleep transitions. The OX2R antagonist increased NREM duration but not the OX1R antagonist. REM sleep was not affected either by OX2R or OX1R blockade alone, but administration of the OX1R antagonist in combination with the OX2R antagonist reduced REM sleep latency and increased REM sleep duration at the expense of NREM sleep. Pharmacological OX1R blockade selectively promoted REM sleep in OX2R KO but not in WT mice.

Conclusion: These results indicate that additional blockade of OX1R to OX2R antagonism elicits a dysregulation of REM sleep by shifting the balance in favor of REM sleep at the expense of NREM sleep that may increase the risk of adverse events. Translation of this hypothesis remains to be tested in the clinic.

0008

OREXIN RECEPTOR ANTAGONISTS PROMOTE BOTH NON-REM AND REM SLEEP SIMILAR TO PHYSIOLOGICAL SLEEP ONSET IN PRE-CLINICAL SPECIES

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Introduction: Orexin receptor antagonists provide a novel treatment for insomnia by reducing wakefulness and enabling sleep. In clinical trials, dual orexin receptor 1/2 antagonists (DORAs) decrease latency to persistent sleep and promote sleep maintenance in insomnia patients while promoting both non-REM (NREM) and REM sleep. Since insomnia patients exhibit reduced NREM and REM sleep, increasing both NREM and REM is important. Assessing structurally

distinct DORAs and selective OX2 receptor antagonists (SORAs) in pre-clinical species is a translatable method for evaluating insomnia therapeutics. Sleep architecture and qEEG effects of DORAs, SORAs and GABAA receptor modulators were compared to that of natural sleep in rats, dogs and monkeys.

Methods: Wireless bio-physiological devices in rats, dogs and monkeys assessed electroencephalogram, electromyogram, electrooculogram (dog & monkey) and locomotor activity 24 hr/day in multi-day cross-over studies. Sleep architecture parameters were compared between vehicle treatment during the inactive period and novel DORA, SORA or GABAA receptor modulator treatment during the active period (insomnia model). A series of structurally distinct compounds were evaluated.

Results: In baseline recordings, both NREM and REM sleep were significantly increased at sleep onset in rats, dogs and monkeys. All compounds promoted NREM sleep when dosed in the active phase, however unlike GABA-A modulators, DORAs and SORAs also increased REM similar to that of baseline sleep onset; there were no generalizable characteristic NREM/REM differences between DORA and SORA sleep. By comparison, benzodiazepine and non-benzodiazepines significantly reduced REM sleep and disrupted qEEG spectral power relative to baseline sleep.

Conclusion: In nonclinical studies both DORAs and SORAs increase NREM and REM sleep across preclinical species. Given that insomnia patients exhibit decreases in both NREM and REM sleep, therapeutics which restore NREM and REM sleep may be appropriate, and further clinical evaluations would be informative.

Support (If Any): Research support was provided by Merck Research Laboratories, Merck & Co., Inc.

0009

PHARMACOLOGICAL AND GENETIC EVALUATION OF OREXIN RECEPTOR ANTAGONISTS IN PRE-CLINICAL ANIMAL MODELS OF PAIN

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Introduction: Orexin peptides and their receptors Ox1R and Ox2R have been postulated to play a role in modulating pain responses. In the present study, we investigated the effects of orexin receptor antagonists DORA-2 and DORA-12, as well orexin receptor KO mice in multiple pre-clinical pain models.

Methods: Orexin receptor antagonists (DORA-2, DORA-12) and genetic knockout animals were evaluated in a combination of rodent models of inflammatory pain (Formalin, CFA), neuropathic pain (Spinal Nerve Ligation (SNL), Chronic Constriction Injury (CCI), thermal sensitivity (Hot Plate) and locomotor performance (rotarod).

Results: In the formalin pain model DORA-12 at 30 mg/kg in wild type and Ox1R KO mice significantly demonstrated antinociceptive effects in early and late phases. Ox1R, Ox2R and Ox1/2R KO mice demonstrated significant antinociceptive effects in late phase. In the Complete Freund's Adjuvant model 10 and 30 mg/kg DORA-2 significantly reduced mechanical hypersensitivity. In the spinal nerve ligation model DORA-2 and DORA-12 at 10 and 30 mg/kg significantly reduced mechanical hypersensitivity. In the Chronic Constriction Injury model 10 and 30 mg/kg of DORA-2 significantly reduced nociceptive response. No effect was on thermal stimuli or motor coordination was demonstrated with DORA-2 or Ox1/2R KO mice.

Conclusion: The results of these nonclinical studies indicate blockade of orexin receptor signaling modulates nociceptive processing in a range of rodent models. Further clinical analyses will be required to understand the potential translatability of these nonclinical observations.

0010

ALTERATIONS IN SLEEP EEG WAVEFORMS INDUCED BY TEMAZEPAM: A HIGH-DENSITY EEG INVESTIGATION

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Introduction: Benzodiazepines are commonly used medications that reduce slow wave activity and increase spindle range/beta activity during sleep. However, prior investigations have utilized limited EEG derivations to evaluate the effects of benzodiazepines on sleep EEG. Functionally significant EEG waveforms such as slow waves and sleep spindles have typical topographic distributions across the cortex. Thus this study sought to utilize high-density EEG (hd-EEG) to investigate topographic changes in spectral activity and sleep spindles induced by the benzodiazepine temazepam.

Methods: This study utilized 18 healthy adult individuals that were drawn from a larger sleep pharmacotherapy study. After an accommodation night, sleep for all participants was recorded on two separate nights after taking either placebo or oral temazepam 15 mg (open-label). Sleep was monitored using 256-channel hd-EEG. Spectral analysis of EEG data and sleep spindle counts/morphology were performed for each participant night. Global and topographic data were subsequently compared between temazepam and placebo nights using paired t-tests.

Results: Temazepam was associated with significant reductions in global spectral power from 1-8.67 Hz, and increases in spectral power from 10.33-13.83 Hz and 16.83-27.0 Hz. Topographic analysis demonstrated that reductions in low frequency activity were evident across the entire scalp, but were most prominent in frontal/midline derivations for both of the higher frequency ranges. Analysis of sleep spindles within the 10.33-13.83 Hz band demonstrated global increases in spindle duration, with modest topographic increases in right parieto-occipital spindle density and fronto-central spindle amplitude. Notably, temazepam was also associated with decreased central sleep spindle density in the 13.83-16 Hz frequency band.

Conclusion: The benzodiazepine temazepam is associated with both global and topographic alterations in spectral activity and sleep spindle density and morphology. Further research is warranted to determine the functional significance of these findings, including how they may be related to both the therapeutic benefits and undesirable side effects of this medication.

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0011

POTENTIATING PENTOBARBITAL-INDUCED SLEEP IN OVARIECTOMIZED MICE OF CHAIHUJIALONGGUMULI DECOCTION, A TRADITIONAL CHINESE MEDICINE

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Introduction: Chaihuojialonggumuli decoction originated from Shang han lun (Treatise on Febrile Diseases), which is often prescribed for perimenopausal syndrome and insomnia in traditional Chinese medicine. Insomnia and other sleep disorders are quite common among perimenopausal women. In this study, we examined the potentiated pentobarbital-induced sleep of the effective parts of Chaihuojialonggumuli decoction on ovariectomized mice with electrical stimulation.

Methods: The decoction of Chaihuojialonggumuli was passing through D101 macroporous resin, sequentially eluting with water, 30% ethanol, 50% ethanol, and 70% ethanol, and the eluate was collected and freeze dried. Ovariectomized female ICR mice were divided into 5 groups. These animals were applied electrical stimulation (voltage: 36v, electric shock once per second, procedure: with a 10-second "on" period followed by a 50-second "off" period, cycle ten times, 8:00 am-10:00 am, for 14 consecutive days) at 7 days after ovariectomy. The groups was received the eluate and water for seven days at 7 days after electrical stimulation. Afterwards, an injection of pentobarbital (55 mg/kg, i.p.) was administered. The time spent from drug injection to loss of righting reflex was considered as sleep latency and the time from loss of righting reflex to its recovery was considered as sleep time.

Results: Compared to control, 70% ethanol elution had significant increases in sleep time ($P < 0.05$), but the change in sleep latency was not significant.

Conclusion: 70% ethanol elution of Chaihuojialonggumuli decoction produced a significant potentiating pentobarbital-induced sleep in ovariectomized mice with electrical stimulation.

Support (If Any): Research Fund of Heilongjiang University of Chinese Medicine (2012bs01).

0012

ORIGINAL RESEARCH: EFFECTS OF QUETIAPINE ON SLEEP PARAMETERS AND ARCHITECTURE

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Introduction: Quetiapine is an atypical antipsychotic agent, it acts as an antagonist at serotonin (5-HT 1A and 5-HT 2), dopamine (D 1 and D 2), histamine (H 1) and adrenergic alpha 1 and 2 receptors, there is virtually no action on cholinergic, muscarinic and benzodiazepine receptors. This special receptor profile suggests a favorable effect on sleep, especially because of the combination of a 5 HT 2 receptor and an H 1 receptor blockade.

Objectives: To determine effects of quetiapine on polysomnographic recorded sleep parameters and architecture to determine utility of this agent in management of various disorders.

Methods: A cross-sectional retrospective study of a convenience sample ($n = 42$) conducted at the sleep center in a community-based, tertiary care, hospital. Medical and polysomnographic sleep records were selected and reviewed from among patients who presented over 24-months for evaluation. 21 patients were selected and matched based on age, sex, body-mass index (BMI), and the presence/absence of obstructive sleep apnea (OSA) to control without Quetiapine. Correlation analysis was performed to assess the association of Quetiapine with sleep efficiency, sleep and REM latency, wake time after sleep onset (WASO), and relative percentage of N1, N2, N3 and REM.

Results: The study population was 57% female with a mean age of 44.8 years and mean BMI of 37.5. A higher proportion of patients with OSA were in the group without use of Quetiapine (81%, $n = 17$). Use of Quetiapine was not significantly associated with altered sleep efficiency, sleep latency, WASO, or the relative percentage of sleep stages. A notable, but not significant ($p = 0.08$), increase in the REM latency was observed.

Conclusion: Among the study population use of Quetiapine was not associated with a change in sleep efficiency, sleep and REM latency, WASO, or percentage of N1, N2, N3 and REM.

0013

INTRASTRIATAL ADMINISTRATION OF THE D2 AGONIST QUINPIROLE MODULATES SLEEP IN A DOSE-DEPENDENT FASHION*Albers JA, Khan N, Varade N, Anch M*

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Introduction: Dopamine is a catecholamine neurotransmitter with multiple central nervous system roles, including facilitation of locomotion and, putatively, regulation of sleep. Cell body-specific lesions of the striatum and globus pallidus have been demonstrated to increase and decrease sleep propensity in the rat, respectively. Striatal neuron activation is controlled, in part, by dopamine activity. Specifically, D2 receptors on striatopallidal GABAergic medium spiny neurons decrease basal ganglia indirect pathway output and disinhibit globus pallidus externa neurons. It is possible that disinhibition of GABAergic pallidocortical neurons is necessary for the facilitation of sleep, and that the D2 receptor is a pharmacological candidate for sleep facilitation via basal ganglia regulation.

Methods: Seven adult male Sprague-Dawley rats were implanted with bilateral intrastriatal cannula, targeted to the dorsolateral quadrant of the striatum. Two doses of quinpirole (50 mcg/mL/h and 500 mcg/mL/h) were administered during separate 12-hour sleep recording sessions (0800-2000 h) and compared to vehicle infusion. Two hours of open-field testing were also recorded during quinpirole or vehicle infusion prior to sleep recording. Prior to sacrifice, rats were infused with 2% methylene blue per cannula to ascertain infusion location histologically.

Results: Low dose (50 mcg/mL/h) quinpirole significantly increased high voltage sleep while moderately increasing locomotion prior to sleep recording, relative to vehicle control. High dose (500 mcg/mL/hr) quinpirole significantly reduced sleep time and increased locomotion prior to sleep recording.

Conclusion: The D2 receptor may offer a potential target for the modulation of sleep propensity. Biphasic effects at differing doses may be a result of the competing behaviors of sleep and motoric activity, both of which may be facilitated by dopamine. At low doses, normal sleep may be permitted, while at high doses, motoric facilitation may prevent sleep initiation or maintenance. These findings may be relevant for disease of dopamine dysregulation, including Parkinson's disease and schizophrenia, each of which commonly present with profound sleep disturbances.

0014

CHRONIC PHARMACOLOGICAL STIMULATION OF BROWN FAT PROMOTES SLEEP IN MICE*Kapás L, Szentirmai É*

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Introduction: We previously showed that intact thermogenic activity of brown adipose tissue (BAT) is essential for maintaining normal sleep-wake activity and homeostatic sleep responses to sleep deprivation in mice. BAT activity is under the control of the sympathetic nervous system via β 3-adrenergic receptors (AR). Norepinephrine-induced activation of β 3-ARs on brown adipocytes leads to BAT activation. We demonstrated that acute, selective, pharmacological stimulation of the β 3-ARs increases body temperature and promotes sleep in mice and this effect is dependent on the presence of UCP-1 protein in the BAT. In the present experiments, we tested the effects of chronic activation of BAT on sleep-wake activity in mice.

Methods: Male C57BL/6 mice ($n = 12$) were instrumented for sleep and body temperature and motor activity recordings. After a 10-day recovery period, baseline sleep, activity and body temperature were recorded for three days. To activate BAT chronically, half of the animals ($n = 6$, experimental group) were implanted with osmotic minipumps in the abdominal cavity filled with the selective β 3-adrenergic agonist, CL316, 243. The minipumps released 1 mg/kg/day CL 326, 243. The other half of the mice received saline-filled minipumps ($n = 6$, control group). Sleep, motor activity and body temperature were recorded for 14 days after minipump implantation.

Results: Chronic stimulation of BAT significantly increased non-rapid-eye movement sleep (NREMS) and rapid-eye movement sleep (REMS), as well as body temperature. Mice that received CL316, 243 had more NREMS and REMS during the dark phase compared to their baseline sleep-wake activity as well as to the control group. Motor activity significantly decreased during the dark phases in CL 316, 243-treated mice. After an initial increase, body temperature of CL 316, 243-treated mice was lower during the dark phases of the experiment.

Conclusion: Present findings further support the notion that the activation of BAT via β 3-AR leads to increased sleep in mice.

Support (If Any): Faculty Seed Grant from Washington State University to LK and ES.

0015

HYPOXIA INDUCIBLE FACTOR-1 MEDIATES INCREASED HEPATIC LYSYL OXIDASE IN HYPOXIA, AND LIVER FIBROSIS IN DIET INDUCED HEPATIC STEATOSIS*Mesarwi O, Shin M, Bevans-Fonti S, Jun J, Polotsky V*

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Introduction: Obstructive sleep apnea (OSA) is associated with the progression of non-alcoholic fatty liver disease to liver inflammation and fibrosis. This progression is correlated with the intermittent hypoxia of OSA. We have previously shown that hypoxia induces hepatocyte expression of lysyl oxidase (LOX), an enzyme which cross-links collagen. We hypothesized that this increase in LOX is mediated by hypoxia inducible factor-1 (HIF-1), and that HIF-1 deficiency may lead to decreased liver fibrosis.

Methods: First, hepatocytes were isolated from wild-type mice and hepatocyte-specific HIF-1 knockout (Hif1a^{-/-}hep) mice. Cells were plated either in 16% oxygen or 1% oxygen for 24 hours, and RT-PCR was used to quantify LOX mRNA expression. Second, wild-type mice and mice with a partial global HIF-1 deficiency (Hif1a^{+/-}) were exposed to intermittent hypoxia for four weeks. LOX mRNA was measured. Finally, wild-type and Hif1a^{-/-}hep mice were fed a high trans-fat diet for 26 weeks, to induce hepatic steatosis. Hepatic fibrosis was evaluated by Sirius red stain and collagen quantification.

Results: Isolated wild-type hepatocytes exposed to hypoxia produced a 5.9-fold increase in LOX expression ($p < 0.05$) relative to those in normoxia. This effect was abolished in Hif1a^{-/-}hep mouse hepatocytes, where no difference was observed in hypoxia versus control. Hepatic LOX expression in wild-type mice exposed to IH was increased 4.8-fold ($p < 0.01$) relative to control; there was no increase in LOX expression in response to IH in Hif1a^{+/-} mice. Finally, wild-type mice on a high trans-fat diet for 26 weeks had 80% more hepatic collagen than Hif1a^{-/-}hep mice (2.21 μ g collagen/mg liver tissue, versus 1.23 μ g collagen/mg liver tissue, $p = 0.03$).

Conclusion: HIF-1 mediates an increase in hepatocyte LOX expression in hypoxia. HIF-1 also appears to play a crucial role in the development of liver fibrosis even in the absence of IH exposure, perhaps due to liver tissue hypoxia in hepatic steatosis. Ongoing experiments will determine whether HIF-1 deficiency will attenuate liver fibrosis in IH exposure in mice with diet induced hepatic steatosis.

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0016

COMMON GLUCOSE LEVEL RISK VARIANTS IN MTNR1B ASSOCIATE WITH INSOMNIA AND SHOW GENE ENVIRONMENT INTERACTION WITH GLUCOSE LEVELS IN A FINNISH POPULATION SAMPLE*Ollila H¹, Kronholm E², Kettunen J³, Silander K³, Perola M³, Salomaa V⁴, Paunio T³*

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Introduction: Epidemiological studies have shown a connection between sleep, type 2 diabetes mellitus (T2DM) and blood glucose levels. All these traits have a strong genetic component. However, it has remained unclear if sleep and glucose metabolism are regulated by the same factors and genes. This study aimed to evaluate if the com-

mon risk variants in melatonin receptor 1B (rs1387153, rs2166706 and rs10830963) that previously associated with blood glucose levels and T2DM 1) contribute directly to variation in sleep, insomnia and chronotype and 2) whether sleep modifies the association between MTNR1B risk variants and glucose levels.

Methods: The study was performed in Finnish population samples where information on sleep duration, insomnia, chronotype and blood glucose levels were available (N = 4691 for discovery and 5825 for replication).

Results: The study confirmed the previously reported association with fasting glucose levels at the genome-wide significant level for rs10830963 and rs1387153. In addition, interaction of rs10830963 and insomnia was observed: individuals with insomnia symptoms and rs10830963 or rs1387153 risk variant had higher blood glucose levels than those without insomnia. Rs2166706 associated significantly with morningness. The association of rs10830963 with blood glucose levels, insomnia and the interaction of rs10830963 with insomnia were replicated in the follow-up sample.

Conclusion: Interaction between rs10830963, blood glucose levels and self-reported insomnia suggests that insomnia modifies the association of rs10830963 with glucose levels. The findings may explain part of the connection between poor sleep and high blood glucose levels.

0017

SLEEP/WAKE CHANGES IN SPONTANEOUS AND EVOKED NEURONAL ACTIVITY MEASURED IN THE DROSOPHILA BRAIN USING CALCIUM IMAGING*Bushey D, Tononi G, Cirelli C*

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Introduction: Electrical activity is reduced in sleep relative to wake throughout the *Drosophila* brain, but changes in neuronal activity at the individual cell level have not been described. We performed in vivo calcium imaging in the calyx and cell body regions of the mushroom bodies (MB) using GCaMP5, a genetically encoded probe whose fluorescence increases when it binds to calcium, providing a measure of neuronal activity.

Methods: Females expressing GCaMP5 in MB were tested after sleep (5-9 h; n = 24), short-term wake (5-9 h; n = 41) or long-term wake (29-32 h; n = 27). A 2-photon microscope measured GCaMP5 fluorescence while video imaging monitored leg and abdomen movements, to determine behavioral state during imaging. GCaMP5 fluorescence was measured before, during, and after repeated odor stimulation, over a 20 min. period to assess differences in spontaneous and evoked neuronal activity, and consistency in the evoked response across animals. In a second experiment, after either being allowed to sleep (2-5 h, n = 10) or sleep deprived (2-5 h, n=17), fluorescence was monitored over a 2 h period keeping the conditions constant, to assess changes in neuronal activity between sleep and wake behaviors in individual animals.

Results: Flies that slept during imaging (n = 15) showed lower calcium levels during baseline (before odor stimulation) than flies that were awake (n = 70). When awake flies were subdivided based on the amount of locomotor activity during imaging (quiet and active wake), differences in calcium levels were only present between sleep and quiet wake, while sleep and active wake did not differ from each other. When single flies were imaged over a period of 2 h, a consistent decline in calcium levels occurred during transitions from wake to sleep (n = 18 episodes). In response to odors, sleeping flies showed weaker changes in neuronal activity than awake flies. Sleep/wake history affected the ability to respond to odors: pairwise Pearson's correlation found a consistent specific activation pattern in response to odors after sleep and short-term wake, while after prolonged wake this activation pattern became inconsistent. Cells that showed maximal response to odors also became less frequent after long-term wake.

Conclusion: Calcium imaging shows that cells in the mushroom bodies are less active and less responsive to odor stimulation during sleep than during wake. Prolonging wake beyond its physiological duration impairs stimulus specific activation patterns that are necessary in learning and memory paradigms

Support (If Any): Supported by NIMH (R01 MH099231 to GT and CC).

0018

SLEEP IS ASSOCIATED WITH NUCLEAR ACCUMULATION OF ARC/ARG3.1 IN LAYERS II-III OF MOUSE MOTOR CORTEX

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Introduction: The activity-regulated cytoskeleton associated protein Arc/Arg3.1 is important for many forms of plasticity, including synaptic potentiation and depression, as well as homeostatic downscaling. After induction in response to neuronal activation, Arc mRNA is rapidly translated in the cell body and distally in the dendrites. In response to sustained neuronal activation, Arc has been shown to 1) enter weakly stimulated synapses and promote their depression by promoting the endocytosis of AMPA receptors; 2) enter the nucleus and mediate cell-wide synaptic downscaling by repressing the transcription of the same receptors. Sleep is thought to promote synaptic renormalization in response to a net increase in synaptic strength during wake, but the underlying molecular mechanisms remain unknown. Here we examined whether the subcellular localization of Arc changes during sleep/wake cycle.

Methods: EGFP-Arc transgenic mice were entrained under 12 h light:12 h dark conditions and sacrificed at the end of the dark period after 12 h spent mostly awake (wake, n = 4). Other mice also spent the night mostly awake, and were then collected during the day after 2 h or 8 h spent mainly asleep (2 h sleep, n = 4; 8 h sleep, n = 3). EGFP-Arc signal was intensified with anti-GFP antibody and the nuclear boundary was defined with nucleic acid staining. Confocal microscopy images were acquired in layer II-III and layer V of primary motor cortex. Nuclear and cytoplasmic Arc expression were measured and the nuc:cyto ratio was quantified.

Results: After 8 h of sleep, very few cells showed Arc staining, consistent with previous studies. After wake or 2 h of sleep, most (~70%) cortical cells showed some Arc staining in both nucleus and cytoplasm, and the number of Arc+ cells did not differ between the 2 groups. Both groups also showed a strong positive correlation ($Rho = -0.69$ and $p < 0.0001$ in wake, and $Rho = -0.77$ and $p < 0.00001$ in sleep) between nuc:cyto ratio and nuclear Arc expression, suggesting that continuous neural activity promotes nuclear accumulation of Arc. The Arc nuc:cyto ratio was significantly higher after 2 h of sleep than after wake in layer II-III neurons ($p < 0.001$, KS-test). Interestingly, the higher nuc:cyto ratio in sleep was observed only in neurons with the strongest Arc signal.

Conclusion: The nuclear accumulation of Arc, which has been shown to mediate synaptic downscaling, increases after sleep.

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0019

INTACT MACROPHAGE FUNCTION IS REQUIRED FOR NORMAL RECOVERY SLEEP AFTER SLEEP LOSS

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Introduction: We have previously shown that thermogenic activity of brown adipose tissue (BAT) is necessary for normal sleep-wake activ-

ity and sleep deprivation-induced rebound sleep. BAT is activated by norepinephrine (NE) released from postganglionic sympathetic neurons and from a recently recognized macrophage population, the alternatively activated (M2) macrophages. The heat-producing capacity of BAT is severely impaired in the absence of M2 macrophages. In the present experiments we tested the hypothesis that intact macrophage function is also required for normal rebound sleep after sleep loss. Macrophage depletion was elicited by systemic injection of clodronate-containing liposomes.

Methods: Male C57BL/6 mice (n = 15) were instrumented for sleep and body temperature recordings. After 10 days of recovery, baseline sleep and temperature were measured for two days. On the experimental day, the control group (n = 7) received intraperitoneal (ip) injections of isotonic saline and the experimental group (n = 8) was injected with clodronate-containing liposomes in a dose of 0.2 ml/mouse. All injections were performed 5-10 minutes before dark onset. Sleep-wake activity and body temperature was measured to determine the acute effects of macrophage depletion as well as its effect on recovery sleep after sleep deprivation. Eighteen h after clodronate administration, mice were sleep deprived by gentle handling during the last 6 h of the light phase.

Results: Macrophage depletion elicited an immediate robust increase in non-rapid-eye movement sleep (NREMS) and decrease in rapid-eye movement sleep (REMS). NREMS increased by 110 ± 38.9 min and REMS decreased by 30 ± 6.8 min across 24 h after clodronate treatment. NREMS intensity was suppressed during the initial 12 h after injection. Sleep deprivation elicited rebound increases in NREMS, REMS and SWA in both groups of mice, however, the increases were significantly, ~50% smaller in the clodronate-treated mice.

Conclusion: Present findings support the hypothesis that intact M2 macrophage function in BAT is required for compensatory sleep after sleep loss.

Support (If Any): Faculty Seed Grant from Washington State University to ES.

0020

CD4+ T CELL HYPOCRETIN/OREXIN CROSSREACTIVITY TO A 2009 H1N1 INFLUENZA A EPIOTOPE IN NARCOLEPSY

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Introduction: Narcolepsy, a disorder strongly associated with Human Leukocyte Antigen (HLA)-DQA1*01:02/DQB1*06:02 (DQ0602), is characterized by excessive daytime sleepiness, cataplexy, and rapid eye movement (REM) sleep abnormalities. It is caused by the loss of ~70,000 posterior hypothalamic neurons that produce the wake-promoting neuropeptide hypocretin (orexin). DQ0602-binding hypocretin (HCRT) epitopes, HCRT56-68 and HCRT87-99, can activate a subpopulation of CD4+ T cells in narcolepsy patients, but not in DQ0602-positive healthy control subjects.

Methods: Because of the established association of narcolepsy with the 2009 H1N1 influenza A strain (pH1N1), we administered a seasonal influenza vaccine (containing pH1N1) to patients with narcolepsy and found an increased frequency of circulating HCRT56-68 and HCRT87-99-reactive T cells. We also identified a hemagglutinin (HA) pH1A1 epitope specific to the 2009 H1N1 strain, pH1A1 275-287, with homology to HCRT56-68 and HCRT87-99.

Results: In vitro stimulation of narcolepsy CD4+ T cells with pH1N1 proteins or pH1A1 275-287 increased the frequency of HCRT56-68 and HCRT87-99-reactive T cells.

Conclusion: Our data indicate the presence of CD4+ T cells that are reactive to HCRT in narcolepsy and suggest molecular mimicry between HCRT and a similar epitope in influenza pH1N1, pH1A1 275-28.

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0021

TRANSETHNIC HLA COMPARISON IN NARCOLEPSY

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Introduction: Narcolepsy is strongly associated with human leukocyte antigen (HLA) DQB1*06:02, and over 90 percent of narcoleptics carry this haplotype. Also several other HLA-genes affect the predisposition to narcolepsy. Recently, the onset of narcolepsy has been associated with H1N1 influenza. All these findings suggest an autoimmune basis for narcolepsy. The aims of this study were to study the contribution of various HLA haplotypes to narcolepsy and clinical phenotypes related to narcolepsy.

Methods: We used direct HLA genotyping and two HLA imputation tools: HIBAG and HLA-IMP that were used for samples where direct HLA genotyping was not possible. The study was performed in Caucasian and Asian samples.

Results: HLA imputation was of high quality both with HIBAG and with HLA-IMP. We replicated earlier reported HLA-associations with HLA-DQB1. In addition, we found significant associations with age of onset and with comparison before or after 2009 H1N1 influenza.

Conclusion: Our results further highlight the importance of HLA in narcolepsy.

Support (If Any): Sigrid Juselius Foundation, Instrumentarium Science Foundation.

0022

DISTURBANCE OF MAXILLOFACIAL BONE GROWTH INDUCED BY INTERMITTENT HYPOXIA IN GROWING RATS

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Introduction: Obstructive sleep apnea syndrome (OSAS) is a common respiratory disorder characterized by partial or complete upper airway obstruction during sleep, causing intermittent hypoxia (IH). IH plays a key role in the pathogenesis of OSAS. In children with OSAS, the situation of low oxygen saturation during sleep can result in general growth retardation and weight loss. However, the influence of IH upon craniofacial growth has not been clearly understood. The aim of this study was to investigate whether and how craniofacial growth was disturbed by IH in growing rats.

Methods: Seven-week-old male Sprague-Dawley rats were randomly divided into the experimental and control groups. Rats in the experimental group were exposed to IH at a rate of 20 cycles/h (nadir 4% O₂ to peak 21% O₂ with 0% CO₂ for 8 hours per day for four days (n = 4) or

three weeks (n = 5). In the control group, rats were subjected to breathe room air for four days (n = 4) or three weeks (n = 5). Lateral and transverse X-rays of rat maxillofacial region were taken for landmark-based morphometric analysis. Bone structure was analyzed using parameters including bone-volume/tissue volume (BV/TV) by microcomputed tomography (micro-CT). Data were statistically analyzed using an unpaired t-test (P < 0.05).

Results: X-rays showed a significant decrease in the linear distance between landmarks of the maxillofacial bone in the experimental group that received IH for three weeks when compared with the control group. Both proportion of the nasal bone to neurocranium length and proportion of the mandibular length to neurocranium length were significantly decreased in IH rats. Three-dimensional micro-CT analysis of mandibular condyle and tibial metaphysis revealed a significant increase in BV/TV in the experimental group.

Conclusion: Results suggest that IH can disturb the rat maxillofacial bone growth leading to discrepancy of maxillofacial morphology.

0023

THE SELF-TUNING SLEEPING BRAIN: ACTIVITY-DEPENDENT SCALING OF NETWORK ACTIVITY IN THE DEVELOPING BRAIN

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Introduction: During early postnatal life (< postnatal day 11), spontaneous bursts of oscillatory events, called spindle bursts, are the predominant form of cortical activity in the somatosensory cortex. Spindle bursts are generated in response to sensory feedback arising from myoclonic twitching during active sleep, and are hypothesized to be important participants in the process of somatotopic mapping. Importantly, such cortical maps are established during critical periods in development, with lack of peripheral sensory feedback having its deleterious effects on map formation during (P0-P4) a narrow critical window. The neural mechanisms that underlie such critical period plasticity are not fully understood. We hypothesized that lack of peripheral feedback after the critical plasticity window does not disrupt somatotopic map formation by recruiting mechanisms of homeostatic scaling of network activity and activity-dependent gene expression.

Methods: Studies were performed on head-fixed, neonatal rat pups (P4-P8) as they cycled normally between sleep and wakefulness in a stereotaxic setup. Bilateral surface EEG recordings were performed in the primary somatosensory barrel cortices (representing the whisker follicles) using custom-made bipolar silver electrodes. To prevent twitch-related sensory feedback, unilateral facial motor nerve incisions to the whisker pad musculature were performed. In addition, we used real-time quantitative PCR to examine the expression of plasticity-related genes that are known to be activity-dependent.

Results: Our preliminary findings demonstrate that at all ages tested, spindle bursts were still generated despite the lack of unilateral motor nerve supply to whisker pad musculature (33%, 20% and 2% drop in the number of spindle bursts compared to the control side at P4, P6 and P8 respectively). We further demonstrate an increase in the expression of plasticity-related genes in barrel cortical tissue that was deprived of peripheral sensory feedback.

Conclusion: This research suggests that developing neural circuits are capable of undergoing homeostatic synaptic scaling that allow for steady output firing rates. This capability along with particular gene expression responses may prevent deleterious network formation after peripheral sensory deprivation after the closure of critical plasticity windows.

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0024

SLEEP PHENOTYPE CHARACTERIZATION OF MUSCLEBLIND-LIKE 1 AND 2 KNOCKOUT MICE, PERIPHERAL AND CENTRAL MODELS OF MYOTONIC DYSTROPHY

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Introduction: Excessive daytime sleepiness and associated alterations in REM sleep patterns are among the most characteristic non-muscular features of myotonic dystrophy (DM). Neurobiological mechanisms likely play significant roles on sleep problems in DM. DM is caused by an expanded C(C)UG repeat that sequesters muscleblind-like protein 1 (MBNL1) and MBNL2, proteins that regulates alternative splicing required for fetal to adult developments. Major pathological changes in the DM brain are attributable to MBNL2 sequestration by toxic RNAs and dysregulation of specific alternative splicing events required for

normal adult CNS function. We thus performed sleep evaluations on Mbnl1 and Mbnl2 knockout (KO) mice.

Methods: Adult wild and KOs of Mbnl1 (n = 7) or Mbnl2 (n = 8) at 6 month of age were implanted with EEG/EMG electrodes. Data acquisition was performed 3 times every 3 months. Sleep deprivation was performed after one full day of baseline by gentle handling.

Results: Mbnl1 and Mbnl2 KOs had normal amounts and natural diurnal distributions of wakefulness and NREM sleep in the 12:12 LD condition. Shorter sleep latency and modest wake fragmentation during dark periods were observed in Mbnl2 KOs. However, the most profound sleep phenotypes observed in Mbnl2 KOs were an increase in REM sleep amounts, associated with increased numbers of REM sleep episodes and increased EEG theta power. This change was most notable during the dark/active period. Cataplexy or direct transition from Wake to REM sleep was not seen in Mbnl2 KOs. A change in REM sleep homeostasis in Mbnl2 KOs was also observed during rebound sleep after a 6-hr sleep deprivation period initiated at ZT 0, where a more profound REM, but not NREM, sleep rebound was observed in Mbnl2 KOs. These REM specific changes were not observed in Mbnl1 KOs.

Conclusion: Our results indicate that Mbnl2, but not Mbnl1, KO mice exhibit increased REM sleep propensity, suggesting REM-associated sleep abnormalities in Mbnl2 KOs are caused by dysregulation of specific alternative splicing events in the brain. This may be one of the most important sleep abnormalities in DM, as selective increase in REM sleep propensity by REM sleep deprivation in human induces significant sleepiness and fatigue during the daytime. REM sleep characteristics in DM might be a residual of infant-type REM sleep, as infants of altricial species spend a large majority of their time in REM sleep, and this model is likely useful to study ontogenic changes in REM sleep during early development.

0025

PRONOCICEPTIVE BEHAVIOR IN ADOLESCENT MICE: AN EFFECT OF SLEEP RESTRICTION DURING POSTNATAL DEVELOPMENT

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Introduction: Sleep in neonates is a physiological event able to promote proper brain activity to the sensory systems in which development is dependent upon activity. Sleep loss can lead to negative implications for the maturation of nociceptive system. We tested the hypothesis that neonatal sleep restriction induces a long-term increase on nociceptive response, and that this hypersensitivity occurs by means of changes in the activity of nociceptive pathways.

Methods: Neonatal mice at postnatal day (PND) 12 were randomly assigned to the following groups: control group (CTRL), sleep restriction (SR) and maternal separation (MS). The SR and MS were performed 2 h/day during 10 days (PND 12 until PND 21). The method of gentle handling was used to prevent sleep. After manipulations one set of animals of each litter was submitted to behavioral analysis and then euthanized for plasma collection (PND 21). The second group remained with their dams until PND 22, when they were group-housed by litter and sex until adolescence (PND 35) or adulthood (PND 90). For each developmental time-point, mice were tested for pain-related behaviors.

Results: Neonatal SR significantly increased corticosterone concentrations, indicating that sleep loss is an early-life adversity. In adolescent mice, the SR increased the nociceptive sensitivity in the hot plate test (-23.5% of pain threshold). However, this alteration in nociceptive response was not followed by changes in c-Fos expression, a neuronal activity marker, in the anterior cingulate cortex and primary somatosensory cortex. The pronociceptive behavior present during adolescence

did not persist until adulthood with all mice showed comparable nociceptive response.

Conclusion: Repeated exposures to sleep loss during early-life period are able to induce mild-term changes in nociceptive response. This alteration in nociceptive sensitivity induced by infancy sleep loss may have been reversed during adolescence to enable an adequate behavior repertoire in adult life.

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0026

LOWER SLEEP PRESSURE AT BEDTIME IS ASSOCIATED WITH LONGER SLEEP ONSET LATENCY IN PRESCHOOL CHILDREN

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Introduction: Sleep-onset delay is prevalent in ~25% of young children, increases across early childhood, and is associated with behavioral/emotional problems. Bedtimes in early childhood are determined primarily by parents, which if misaligned with children's individual sleep physiology may contribute to sleep-onset difficulties. This study examined the relationship between the level of sleep pressure (homeostatic Process S) at bedtime and sleep-onset latency (SOL) in 2-5 year-olds.

Methods: Participants were 8 children (3 males) studied at three longitudinal time points (2.5-3.0Y, 3.5-4.0Y, 5.5-6.0Y). Children slept on a habitual, parent-determined schedule for 5 nights. Lights-out (bedtime) and SOL were measured via actigraphy. Individual dynamics of Process S were modeled by an increasing saturating exponential function (upper asymptote 1) during wakefulness and a decreasing exponential function (lower asymptote 0) during sleep. Process S time constants were determined using mean slow-wave activity (0.75-4.5 Hz) at each NREM episode midpoint from non-consecutive EEG recordings (C3A2) obtained at 4, 7, 10, 13, and 16 h of prior wakefulness. The level of Process S (varying between 0 and 1) was computed at LO time.

Results: Analysis included 3 nights of actigraphy (per child, year). On average, SOL was 35.0 ± 20.9 min and Process S level at LO was 0.63 ± 0.10 . A partial correlation controlling for age showed a moderate association between Process S at LO and SOL ($r = -0.42$, $p < 0.001$), such that children put to bed at lower Process S levels had longer sleep-onset latencies.

Conclusion: Putting children to bed at a clock time out of sync with their individual sleep physiology can lead to prolonged sleep-onset latencies. Findings highlight the need to study early sleep problems in the context of interactions between environmental demands and basic properties of the homeostatic regulatory system. Future work should integrate homeostatic and circadian parameters into a model predicting sleep-onset latency in children.

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0027

ADOLESCENT DEVELOPMENT GOVERNS THE RESTORATIVE INFLUENCE OF SLEEP-SPINDLES ON NEXT-DAY HIPPOCAMPAL LEARNING

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Introduction: Sleep-spindles play an important role in restoring next-day hippocampus-dependent learning in adults. However, it is not known how this relationship develops early in life. This is particularly important given the pronounced changes in sleep-spindles and hippocampal function during development. Here, we demonstrate that pubertal stage not only impacts sleep-spindle activity and hippocampal learning, but also determines the relationship between these factors.

Methods: 20 healthy adolescent males (age range: 12-15; mean: 13.7 ± 0.25 years) were categorized by approximate pubertal Tanner stage ($n = 9$ early-puberty [$< \text{Tanner-3}$]; $n = 11$ mid/late-puberty [$\geq \text{Tanner-3}$]). A night of whole-head EEG polysomnography was recorded, followed the next day by an fMRI-monitored hippocampal-dependent associative learning task. Topographical sleep-spindles and hippocampal encoding activity were examined.

Results: First, puberty status influenced hippocampal function. Activation was greater within posterior hippocampus in the early-puberty, relative to the mid/late-puberty, group ($p < 0.001$). Second, pubertal-group additionally determined the restorative relationship between prior sleep-spindles over fronto-central cortex and next-day hippocampal learning activity. Specifically, a strong positive predictive relationship between spindles and next-day hippocampal activity was observed in the early-puberty group ($p = 0.047$), but not in the mid/late-puberty group ($p = 0.50$). Finally, a formal multiple-regression analysis confirmed a significant interaction between puberty status and sleep-spindles in predicting hippocampal activity ($p = 0.047$), indicating that developmental status moderates the relationship between prior-sleep and next-day hippocampal memory function.

Conclusion: Together, these data suggest the restorative impact of sleep-spindles on next-day learning capacity is especially prominent in early stages of adolescent development. Furthermore, this interaction is, in part, governed through the influence of pubertal development. Such findings are particularly relevant at educational- and societal-levels, given the critical importance of learning, and the growing trend of sleep curtailment, amongst adolescents. They additionally offer brain-based evidence to inform policy regarding sleep and school start times.

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0028

HUMAN B-AMYLOID PATHOLOGY IMPAIRS MEMORY IN OLDER ADULTS THROUGH ITS IMPACT ON NREM SLOW WAVES

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Introduction: β -amyloid pathology may underlie memory impairment in older adults. However, whether the influence of β -amyloid pathology on memory retention is, in part, driven by impairments of NREM slow wave activity (SWA) and associated memory consolidation is unknown. Here, we demonstrate that medial prefrontal (mPFC) β -amyloid deposition determines the degree of disrupted quality of NREM SWA, thereby compromising sleep-dependent long-term memory consolidation.

Methods: [11C]PIB PET scans allowing assessment of regional β -amyloid pathology in vivo were obtained in 22 elderly participants (75.0 ± 3.7 years). Additionally, all participants were scanned while performing a sleep-dependent memory consolidation task to assess concomitant hippocampal involvement. Intervening sleep was recorded in-lab using full-head EEG polysomnography. The quality of prefrontal NREM SWA was derived as the proportion of SWA < 1 Hz averaged over CZ and FZ derivations, while fMRI data were acquired post-sleep, during delayed recognition testing. Analyses focused on the interactions between mPFC β -amyloid pathology, prefrontal NREM SWA, hippocampal fMRI activation, and overnight memory consolidation.

Results: The severity of β -amyloid deposition within mPFC ($p = 0.017$) but not temporal cortex ($p = 0.15$) negatively predicted NREM SWA quality. NREM SWA quality, in turn, positively predicted the degree of overnight memory retention ($p = 0.037$), and negatively predicted the degree of post-sleep hippocampal activity ($p = 0.039$). Importantly, and to directly test the interactions of these individual associations, structural equation models revealed that mPFC β -amyloid influenced overnight memory retention through, and not independently of, its influence on the quality of NREM SWA.

Conclusion: These data not only affirm a link between mPFC β -amyloid pathology and impaired NREM SWA, but establish that one consequence of this neuropathological connection is impaired sleep-dependent consolidation of hippocampal-associated episodic memories, leading to diminished long-term memory retention. More generally, these findings implicate NREM sleep disruption as a potential mechanism through which β -amyloid pathology triggers cognitive decline and memory dysfunction in aging and dementia.

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0029

GREY MATTER ATROPHY EXPLAINS IMPAIRED AGE-RELATED DISSIPATION OF HOMEOSTATIC SLEEP PRESSURE DURING THE NIGHT

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Introduction: Slow waves (SW; - 4Hz, + 75 μ V) are sensitive markers of homeostatic sleep pressure, which increase during wakefulness and decrease during sleep. Normal aging is associated with changes in SW regulation and with an impaired build-up/dissipation of homeostatic sleep pressure particularly in the brain's frontal regions. Previous neuroimaging studies have also revealed that aging is associated with reduced cortical thickness (CT; gray matter) particularly in the frontal cortex. This study investigated the role of grey matter atrophy in the age-related effect on homeostatic pressure dissipation

Methods: Polysomnography was recorded in 30 young (20-30 y; 16 men) and 33 older (50-70 y; 15 men) subjects during normal sleep conditions. Mean SW density (nb./min), amplitude (μ V) and slope (μ V/s) between pairs of electrodes (Fp1-Fp2; F3-F4; C3-C4; P3-P4; O1-O2) were calculated for the first four NREM periods (NREMP). We computed an index of homeostatic sleep pressure dissipation using differences in calculated SW properties during the first and last NREMP. Subjects underwent a brain MRI, and CT was calculated over the cortical surface. CT was analysed using linear effects models in SurfStat. Bootstrapped mediation analyses were performed to investigate the role of CT in the age-related attenuation of homeostatic pressure dissipation.

Results: Compared to young subjects, middle-aged subjects showed lower sleep pressure dissipation on all derivations, particularly in frontal regions ($p < 0.001$). Independently of aging, elevated sleep pressure dissipation on frontal derivations predicted thicker cortices in the right infero-temporal (IT) gyrus ($p < 0.001$, RFT-corrected). Mediation analyses revealed that grey matter atrophy in the IT gyrus explained reduction of homeostatic pressure dissipation in older subjects ($p < 0.05$).

Conclusion: For the first time, this study investigated the neuroanatomic correlates of the sleep homeostatic process. Our findings demonstrate that grey matter atrophy in temporal regions explain impaired homeostatic dissipation during normal aging. Future studies should investigate temporal lobe implication in the age-related reduction of SW rebound after sleep deprivation.

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0030

APOE4 GENOTYPE IMPAIRS SLEEP SPINDLE RESTORATION OF NEXT DAY HIPPOCAMPAL-DEPENDENT LEARNING IN OLDER ADULTS

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Introduction: The presence of APOE4 genotype (APOE4+) is a known risk factor for developing Alzheimer's Disease (AD), associated with impaired hippocampal-dependent learning. However, the mechanism(s) of this interaction remains poorly understood. Independent of genotype, recent findings have indicated that prefrontal sleep spindles promote the restoration of post-sleep hippocampal-dependent learning. Here, we demonstrate that APOE4+ older adults exhibit lower sleep spindle-dependent restoration of hippocampal encoding activation and impaired post-sleep learning ability.

Methods: The presence or absence of APOE4 genotype was acquired from 25 elderly participants (73.5 ± 5.4 years; 8 APOE4+). Sleep was recorded in-lab using full-head EEG polysomnography. Following sleep, all participants were scanned while performing a hippocampal-dependent face-name associative learning task. Analyses focused on the interactions between APOE genotype (APOE4+, APOE4-), prefrontal sleep spindles, hippocampal fMRI activation, and learning ability.

Results: APOE4+ genotype was associated with worse associative learning (Mann-Whitney: $p = 0.039$). A multiple regression model predicting learning ability indicated a significant main effect of sleep spindles ($p = 0.014$) and a significant APOE×spindle interaction effect ($p = 0.030$), but no significant main effect of APOE genotype ($p = 0.115$). Similar effects were identified in a multiple regression model predicting hippocampal activation ($p = 0.005$ for sleep spindles, $p = 0.986$ for APOE genotype, $p = 0.003$ for APOE×spindle interaction), with spindles not boosting hippocampal activity in APOE4+ older adults. Further, this moderation effect on learning ability was statistically mediated by the effects of APOE genotype and frontal sleep spindles on hippocampal activation (Sobel mediation test, $p = 0.023$).

Conclusion: These data demonstrate that one mechanism by which APOE4+ genotype triggers learning dysfunction in older adults is by compromising the restorative influence of sleep spindles on next day hippocampal encoding activity. More generally, these findings establish a genetic neuropathological interaction with sleep-dependent memory functioning in older adults, one with significant implications for understanding and potentially treating aspects of cognitive decline in aging and dementia.

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0031

DECLINE OF SLOW-WAVE SLEEP DURING ADOLESCENCE IN A GENERAL POPULATION SAMPLE: GENDER EFFECTS

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Introduction: The relatively higher proportion of SWS in adult women compared to men has been well-documented. The time at which this dimorphism occurs, however, is not clear. While previous studies in

adolescents have addressed this question, they are limited by selective cohorts and small sample size. The aim of this study was to characterize the decline of SWS with age in a large cross-sectional population of adolescents.

Methods: A sample of 421 adolescents (ages 12-23 y, mean 16.7 ± 2.2 y; 53.9% male) from the Penn State Child Cohort, a representative general population sample, underwent a single 9-hour polysomnography (PSG) recording. Multiple linear regression models for percentage of SWS versus age were generated separately for males and females, adjusting for race.

Results: Linear regression models for SWS across age suggest that while males at age 12 have more SWS than females, males undergo a more rapid reduction cross-sectionally across adolescence (-2.64% per year versus -1.73% per year in females). The interaction between age and gender on SWS was significant ($p < 0.001$), and remained when controlling for Tanner (pubertal) stage. According to the models, it is at age 17.1 y that the genders diverge, with males henceforth having a lower proportion of SWS. Age was not associated with a change in total sleep time (TST) or total wake time (TWT).

Conclusion: Males undergo a more rapid decline in SWS than females during adolescence; importantly, the loss of SWS is not driven by a decline in TST or increase in TWT. This gender divergence in SWS may signal the initiation of dimorphic sleep patterns in adulthood. Furthermore, the unexpected finding that this occurs late in puberty may shed light on understanding underlying mechanisms of human brain maturation, as well as the differential pattern of mental and physical health problems between the two genders.

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0032

AGE-RELATED CHANGES IN SLEEP SPINDLE CHARACTERISTICS DURING DAYTIME RECOVERY FOLLOWING 25 HOURS OF SLEEP DEPRIVATION

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Introduction: Sleep spindles are one of the main oscillatory events (~11-15 Hz; > 0.5 s) defining non-rapid eye movement (NREM) sleep. The mechanisms underlying spindles help maintain and protect sleep. With age, it becomes increasingly difficult to maintain sleep at a challengeable time (e.g. daytime), even after a sleep deprivation (SD), due to the wake signal sent by the circadian pacemaker. This study compared spindle characteristics during daytime recovery and nocturnal sleep in young and middle-aged subjects. We also explored the relationship between changes in spindles density and frequency and the ability to maintain sleep during daytime recovery period.

Methods: Twenty-seven young (14W; mean = 27.3 years, SD = 5.1) and 32 middle-aged (19W; mean = 51.7 years, SD = 5.1) healthy subjects participated in a baseline (BSL) nocturnal sleep and a daytime recovery (REC) sleep (after 25-hour SD). Spindles (11.1-14.9 Hz) were detected on artefact-free NREM sleep epochs. Spindle density (nb/min), duration (s), amplitude (µV) and frequency (Hz) were analyzed for Fp1, F3, C3, P3 and O1 (linked-ears) derivations.

Results: In young subjects, spindle frequency increased during REC sleep as compared to BSL sleep in all derivations whereas middle-aged subjects showed spindle frequency enhancement only in the Fp1 derivation. No other interaction between age group and SD was found. No significant correlations were found between changes in spindles density or frequency and changes in sleep efficiency between BSL and REC in young or in middle-aged subjects.

Conclusion: These results suggest that the homeostatic and circadian processes (or their interaction) regulating spindle frequency change with age. However, spindle characteristics do not seem to be linked with the ability to maintain daytime recovery sleep.

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0033

ARE LATE ADOLESCENTS GETTING ADEQUATE SLEEP? AN ANALYSIS OF SLEEP QUALITY AND CHARACTERISTICS OF COLLEGE FRESHMEN

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Introduction: Late adolescence (ages 18 to 21) is a significant time of development and transition. Due to the substantial number of changes occurring during this time of development, many researchers have conducted studies focusing on factors affecting undergraduate students; however, there are few studies that focus on sleep within this population. The purpose of the current research project was to investigate the characteristics and quality of sleep among college freshmen at a university.

Methods: Survey data were collected from 195 college freshmen attending a public university in the western United States; however, 13 participants were excluded from the analysis because they started, but did not complete the survey. Therefore, the actual sample for this study was 182 participants (32% male). The survey was administered online, and included the Pittsburgh Sleep Quality Index (PSQI) as well as demographic questions and questions that collected data on other characteristics typically related to sleep quality (e.g., exercise, substance use).

Results: The majority of participants (97%) reported attending college full time, and 61% were living on campus. 60% of students reported a bedtime of midnight or later and the average rise time was 8:00 am. 69% of students had a sleep efficiency of greater than or equal to 85%, as calculated from the PSQI. The mean global PSQI score was 4.63 (range 1 to 17), indicating relatively healthy sleep overall, although 21% of the sample reported having "fairly bad" or "very bad" sleep quality. The PSQI sleep quality sub scale and self-reported sleep quality were only moderately correlated ($r = .198$, $p = .008$). Reported sleep quality was not related to frequency of exercise, number of credits enrolled in, frequency of reported substance use, or employment status, although there was a small positive correlation ($r = .18$, $p = .035$) between number of work hours and sleep quality.

Conclusion: Overall, the college freshmen in this sample reported relatively healthy sleep quality and characteristics as measured by the PSQI. Other factors typically found to be related to sleep quality were not significant in this sample, with the exception of work hours.

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0034

THE IMPACT OF SLEEP DEPRIVATION ON REGIONAL DIFFERENCES IN SLEEP EEG POWER FROM EARLY TO MID ADOLESCENCE

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Introduction: A developmental decline in slow-wave activity (SWA) along with a progression of maximal SWA from posterior to anterior regions has been shown across adolescent development under baseline sleep conditions (Kurth et al., 2010). SWA also shows a robust increase following sleep deprivation. We examined whether the compensatory increase in SWA to sleep deprivation varied across regions from early to mid adolescence.

Methods: Polysomnography was recorded from 11 EEG derivations during baseline (14 h prior wakefulness) and recovery (32 h prior wakefulness) sleep in 13 early (10-11 years; mean = 10.3 (0.48)) and 30 mid adolescents (15-16 years; mean = 15.4 (0.49)). A mixed model ANOVA with between subjects factor age group (early vs. mid adolescent) and within subjects factor region (11 EEG derivations) was used to compare regional difference in NREM sleep SWA from mid to late adolescence for baseline, recovery, and the ratio of SWA of recovery to baseline nights separately.

Results: We found the expected decline in SWA from mid to late adolescence for baseline ($F = 24.6$; $p < 0.0001$) and recovery ($F = 25.7$; $p < 0.0001$) nights along with a main effect of derivation for each night and the ratio ($p < 0.001$). Furthermore, we found an interaction of derivation with age group for baseline ($F = 4.2$, $p = 0.001$), recovery ($F = 6.7$; $p < 0.0001$) and the SWA ratio of the two nights ($F = 2.3$, $p = 0.04$). All showed more SWA at anterior versus posterior derivations in older groups.

Conclusion: We confirmed a shift of NREM SWA from posterior to anterior areas with age in adolescents, on baseline and recovery sleep and the ratio of the two nights. These results provide evidence that brain regions with most SWA at baseline express greatest recovery after extended wakefulness, as indexed by SWA increase.

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0035

THE EFFECT OF NAPPING ON THE DIURNAL SECRETORY PATTERN OF CORTISOL IN TODDLERS

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Introduction: Cortisol levels in adults show a sharp decrease from midmorning to midafternoon. Most toddlers take afternoon naps, which is associated with a less mature diurnal cortisol pattern characterized by a mid-day plateau in cortisol production. We previously reported a dramatic nap-dependent cortisol awakening response (CAR), which may account for such maturational differences. This experimental study compared the effects of the napping CAR on the diurnal cortisol pattern in toddlers.

Methods: Toddlers ($n = 27$; 12 females; 30-36 months) followed a bi-phasic sleep schedule (≥ 12.5 h time in bed; ≥ 90 min nap) for ≥ 3 days before each of two randomly-ordered, in-home cortisol assessments. On

one day, children napped, and parents collected saliva at morning awakening, 09:30, pre-nap, 0, 15, 30, 45, 90, 135 min post-nap awakening and ~19:30 (wake times verified with actigraphy). On another day, children missed their nap, and saliva samples were obtained at similar times of day. Saliva was assayed for cortisol ($\mu\text{g/dl}$).

Results: Three-level hierarchical linear modeling (HLM 6) was used to estimate the CAR and diurnal cortisol patterns in both conditions. There was a significantly pronounced cortisol rise ($b = 5.35$, $p < 0.01$) when children napped, whereas missing a nap resulted in no CAR ($b = -0.77$, n.s.). Diurnal patterns were analyzed using piecewise growth modeling that estimated linear coefficients for five separate periods throughout the day (corresponding to morning decline, noon decline, post-nap rise, post-nap decline, and evening decline). This analysis confirmed differences between nap and no-nap days by identifying a significant post-nap rise in cortisol values on napping days ($b = 3.83$, $p < 0.05$), and a flat afternoon pattern on days without a nap ($b = -0.20$, n.s.). No other differences in diurnal profiles were observed on napping versus non-napping days.

Conclusion: Our findings suggest that daytime napping influences diurnal cortisol secretion. A more mature pattern may arise as toddlers begin to drop naps. Prior studies of the diurnal cortisol pattern have employed a cubic model, and therefore, have not detected all the variations in patterns that are due to napping. Future studies should examine how the slope of the daytime cortisol pattern corresponds to emotion regulation and other behavioral measures.

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0036

WHITE MATTER INTEGRITY OF THE CORPUS CALLOSUM IS LINKED TO NREM INTERHEMISPHERIC EEG COHERENCE IN OLDER SUBJECTS

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Introduction: Considerable changes happen in NREM sleep synchronization with aging, such as a reduction in delta and sigma spectral activity. The brain also undergoes a decrease in white matter integrity with aging. Here, we aimed to assess whether interhemispheric coherence in delta and sigma is linked to white matter integrity of the corpus callosum in young and older subjects.

Methods: One night polysomnographic recording was performed in thirty young (22.9 ± 2.8) and 30 older (59.6 ± 5.6) healthy subjects. Coherence between pairs of electrodes (Fp1-Fp2; F3-F4; C3-C4; P3-P4; O1-O2) was computed for delta (1-4 Hz) and sigma frequency bands (12-14 Hz) during the first 30 minutes of artifact-free consolidated NREM sleep. Integrity of the corpus callosum was assessed with diffusion magnetic resonance imaging (dMRI) using fractional anisotropy (FA) and mean diffusivity (MD).

Results: Compared to young individuals, older subjects showed lower interhemispheric coherence for the sigma band in C3-C4 ($p < .01$) and P3-P4 ($p < .05$). Coherence also tended to be lower for the delta band in Fp1-Fp2 ($p = .075$). For white matter integrity, FA was lower and MD was higher in older than in young subjects (FA: $p < .00001$; MD: $p < .02$). Older subjects showed positive correlations between FA and sigma coherence in Fp1-Fp2 ($r = .65$; $p < .001$) and F3-F4 ($r = .39$; $p < .05$) and between FA and delta coherence in Fp1-Fp2 ($r = .54$; $p < .01$). Older subjects also showed a negative correlation between MD and sigma coherence in Fp1-Fp2 ($r = -.49$; $p < .01$). No significant correlation was found in the young subjects.

Conclusion: In older subjects only, better interhemispheric coherence in delta and sigma frequencies in anterior regions is associated with higher integrity of white fibers in the corpus callosum. These results show that EEG coherence could be sensitive to the white matter loss accompanying aging. The functional implications of these results should be investigated next.

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0037

THE MODULATING EFFECTS OF SLEEP EFFICIENCY AND AGE ON DEFAULT MODE NETWORK FUNCTIONAL CONNECTIVITY

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Introduction: Recent research has begun to identify how sleep quality may modulate resting-state networks (RSNs) identified in fMRI data. Few studies have examined how sleep quality may interact with advancing age to alter functional connectivity (FC) within (or between) RSNs. We address this by exploring default mode network (DMN) FC as a function of sleep efficiency and age.

Methods: Ten young ($M = 25 \pm 3.3$ years) and ten older ($M = 73 \pm 5.4$ years) participants wore Actiwatches and kept sleep diaries for two weeks prior to a 15-minute waking resting-state fMRI scan. A seed-based approach assessed FC between the posterior cingulate cortex (PCC) and seven other DMN nodes. Sleep efficiency was not significantly different between the age groups therefore participants were divided into good/poor sleepers ($n = 12/8$ respectively), based on a median split of sleep efficiency scores. A generalized linear mixed model was used to assess interactions between sleep efficiency, age group and node in predicting FC.

Results: FC differences between age groups existed only for increased PCC-left PHG FC in the young ($p < .001$). Sleep efficiency significantly modulated FC; in comparison to good sleepers, poor sleepers showed significantly increased FC between: 1) PCC-left IPL ($p = 0.036$) 2) PCC-right MTG ($p = 0.013$) and 3) PCC-left PHG ($p = 0.046$). Furthermore, a significant interaction between age, sleep efficiency and node was identified. Within the good sleep group, PCC-left IPL ($p = 0.026$) and PCC-right IPL ($p = 0.034$) FC was significantly higher in older participants. In contrast, PCC-left PHG ($p < 0.001$) FC was significantly increased in young participants, for poor sleepers only.

Conclusion: Individuals with poorer sleep efficiency displayed stronger FC between certain nodes of the DMN. Furthermore, sleep efficiency was seen to interact with age, resulting in differential patterns of DMN FC for young and older participants, dependent on sleep quality.

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0038

AGE-RELATED DIFFERENCES IN EEG SLOW WAVE ACTIVITY RISE TIME WITH AND WITHOUT ZOLPIDEM BETWEEN HEALTHY YOUNG AND OLDER ADULTS

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Introduction: Slow wave activity (SWA) rise time following sleep onset is a marker of neural synchrony. Aging reduces SWA levels. The hypnotic medication zolpidem is known to decrease sleep onset latency

and improve sleep continuity in the beginning of the night when plasma zolpidem levels are high, but typically does not alter SWA levels in young adults. It is unknown if older age alters SWA rise time or how zolpidem affects SWA in older adults. We therefore assessed age-related differences in SWA rise time with and without zolpidem.

Methods: Thirteen healthy young adults (6 females) aged 21.9 ± 2.2 y (mean \pm SD) and 12 older (8 females) healthy adults aged 67.4 ± 4.2 y participated in a randomized, crossover, double-blind, placebo-controlled study. Zolpidem (5 mg immediate-release) was administered 10 min prior to participant's habitual bedtime. SWA was calculated for 0.75-4.25 Hz EEG power in 2-min bins for the first 30 min following sleep onset for F3-A2, C3-A2, and O1-A2 brain regions. In addition, slow wave energy (SWE) in the first 30 min was calculated as the sum of SWA. Data were analyzed using repeated measures ANOVA and planned comparisons between age groups and Cohen's d effect sizes were calculated for SWE.

Results: Both young and older adults showed significant increases in SWA across the 30 min after sleep onset for placebo and zolpidem conditions in the three brain regions examined (all $p < 0.001$). Older adults however, showed a smaller rise in SWA compared to young adults and zolpidem increased age-related differences in SWA rise time such that differences were observed earlier in young compared to older adults (all $p < 0.04688$). Differences in SWA and SWE between frontal and central brain regions were reduced in older adults.

Conclusion: Findings suggest that aging reduces neural synchrony after sleep onset and attenuates the frontal predominance of SWA and SWE, which persists even after taking zolpidem.

0039

EFFECTS OF ZOLPIDEM ON SLEEP ARCHITECTURE AND NREM SLEEP EEG POWER SPECTRA IN HEALTHY YOUNG AND OLDER ADULTS

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Introduction: Aging alters brain physiology and sleep, and is associated with a lighter sleep phenotype. Sleep medication use is highest among older adults and zolpidem is the most commonly prescribed sleep medication, however no studies have investigated the effects of zolpidem on EEG power in older adults. We therefore compared sleep architecture and EEG power spectra with and without zolpidem in healthy young and older adults.

Methods: Thirteen healthy young adults (6 females) aged 21.9 ± 2.2 y and 12 healthy older adults (8 females) aged 67.4 ± 4.2 y participated in a randomized, crossover, double-blind, placebo-controlled study. Zolpidem (5 mg immediate-release) was given 10 min prior to each participant's habitual bedtime. Sleep stages were scored from C3-A2 and artifact free NREM EEG power spectra were calculated with fast Fourier transform (FFT) in 0.5 Hz bins between 0.75-25.25 Hz for F3-A2, C3-A2, and O1-A2 during the first 110 min of the sleep episode, when plasma zolpidem levels are high. Data were analyzed with mixed model ANOVA with planned comparisons and as percent of placebo using single-sample t-tests.

Results: Regardless of zolpidem or placebo condition, older adults showed less minutes and percent SWS, longer LPS, lower SE, and greater percent wakefulness, minutes of WASO after SOL and LPS, and number of awakenings after SOL compared to young adults ($p < 0.05$). Older, compared to young adults, also showed significantly lower delta power in all brain regions examined and lower theta and sigma power for F3 under placebo and lower theta power for F3 and C3 under zolpi-

dem ($p < 0.05$). Zolpidem reduced stage 1 sleep and reduced theta and alpha powers in older but not younger adults ($p < 0.05$).

Conclusion: Age-related differences in sleep architecture and delta power persist even after taking 5 mg zolpidem. The possible consequences of zolpidem-induced reductions EEG theta and alpha powers in older adults remain to be elucidated.

0040

DIFFERENCES IN FATIGUE AND DEPRESSIVE SYMPTOMS BETWEEN AVERAGE AND LONG SLEEPING OLDER ADULTS

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Introduction: Past research has reported that long sleep is associated with depressive/fatigue related symptoms, however, most of this research have been epidemiological studies. The present study examined symptoms of depression and fatigue between average and long sleeping older adults by using a more objective measure, actigraphy.

Methods: 32 older adults (84% female; mean age 65.2, range 60-77) completed two weeks of actigraphy and were subsequently classified as average sleepers (6-7.25 hrs average time in bed, N = 17) or long sleepers (8-9.5 hrs average time in bed, N = 15). At the end of this two week period, participants completed the Geriatric Depression Inventory (GDI), Multidimensional Fatigue Symptom Inventory Short Form (MFSI-SF), SF-36 Vitality Scale and SF-36 Mental Health Scale. Lower scores on the former two measures indicate better health, whereas higher scores on the latter two indicate better health. Between group comparisons on these measures were examined using 2-tailed independent samples t-tests.

Results: On the SF-36 Mental Health scale, long sleepers (78.4 ± 16.3) scored significantly worse ($p < 0.01$) than average sleepers (92.7 ± 7.0), with a large corresponding effect size (Cohen's d = 1.14). On the SF-36 Vitality scale, long sleepers (64.3 ± 14.9) scored significantly worse than average sleepers (74.7 ± 11.0), ($p < 0.05$), with a moderate-large effect size (Cohen's d = 0.79). On the GDI, long sleepers (N = 12, 6.0 ± 6.3) scored higher than average sleepers (N = 14, 2.9 ± 3.9), though this difference was not significant, ($p < 0.2$), but was associated with a moderate effect size (Cohen's d = 0.59). On the MFSI-SF, long sleepers (N = 14, 16.1 ± 13.3) scored higher than average sleepers (N = 14, 10.6 ± 9.5), this difference was not significant, but was associated with a moderate effect size (Cohen's d = 0.48).

Conclusion: The current results suggest that sleeping for a longer than average period of time in older adults is associated with greater symptoms of depression and fatigue. Analyses with more participants may have the statistical power to detect whether the between-group comparisons on the GDI and MFSI-SF are statistically significant.

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0041

DIFFERENCES IN EEG POWER SPECTRUM DURING NORMAL SLEEP IN CHILDREN AGES 6 TO 12 YEARS: FINDINGS FROM THE TUCASA STUDY

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Introduction: As the brain normally develops across early childhood, a myriad of excessive neuronal synapses reduce (i.e., prune) toward their stable adult levels. Since electroencephalogram (EEG) power represents collections of neurons firing synchronously, synaptic pruning likely results in reduced power seen by the EEG. Studies disagree about the direction and time course of this potential finding. We hypothesized that there would be an inverse association between absolute EEG delta power during sleep and age in children 6-12 years as a reflection of brain maturation and reorganization.

Methods: This is a cross-sectional analysis of 310 Caucasian and Hispanic children recruited from elementary schools to undergo unattended home polysomnography followed by neurocognitive testing. EEG recordings from children without sleep apnea were extracted and analyzed using the techniques of the discrete fast Fourier transform to determine the spectral power (μV^2) for each 30-second epoch of sleep, with the spectral distribution categorized into conventional frequency bands (e.g., delta power: 0.8-4.0 Hz).

Results: Absolute delta power during a night of sleep decreases significantly with increasing age. Comparing the oldest and youngest quartiles of our cohort (age 6-12), delta power during NREM sleep was 17% lower in the older group ($p = 0.04$). With increasing age, the differences in EEG delta power between older and younger children was most pronounced during the first NREM period ($p < 0.001$).

Conclusion: Differences in EEG delta power during sleep are observed with increasing age in a large cohort of healthy children ages 6-12 years. These findings correspond to known periods of synaptic pruning during healthy brain development, and likely represent direct and non-invasive measures of normal brain development during childhood.

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0042

DIFFERENTIAL PROCESSING OF SENSORY FEEDBACK FROM SLEEP-RELATED TWITCHES AND WAKE MOVEMENTS IN THE MOTOR CORTEX OF INFANT RATS

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Introduction: During early postnatal development as limbs and muscles grow in size and proportion, sensory and motor integration must be continuously recalibrated. However, little is known about the mechanisms and processes that make this calibration possible. To address this, we recorded from the hindlimb region of primary motor cortex (M1) in 4- to 10-day-old rats. At these ages, the motor cortex receives sensory feedback from the periphery and can also elicit movements of the limbs. We hypothesized that whereas reafference from twitches would trigger spindle bursts in M1, reafference from wake movements would not. We further hypothesized that exafference arising from evoked stimulation of the limbs would trigger spindle bursts in M1 regardless of whether the pup is asleep or awake.

Methods: Subjects were 4-, 8-, and 10-day-old male and female Sprague-Dawley Norway rats. A head-fix preparation was used to record behavior and M1 local field and multiunit activity in unanesthetized rats. Silicon depth electrodes were used to record cortical activity. A paintbrush was used for manual stimulations of the hindlimb.

Results: Sensory activity in motor cortex preferentially occurred during active sleep. In addition, neural activity increased significantly and substantially after the occurrence of twitches. In contrast, spindle bursts and unit activity were nearly absent during wake movements. Lastly, sensory feedback was evoked identically regardless of the behavioral state of the pup.

Conclusion: Although M1 activity in response to sensory feedback (i.e., reafference) from self-generated movements displays strong state-dependence, M1 responses to evoked stimulations (i.e., exafference) do not. These findings suggest differential gating of corollary discharge signals depending on whether a self-produced movement occurs during active sleep or wake. Accordingly, these findings further support the notion that twitches are a unique form of spontaneous activity that contributes to the development of sensorimotor integration.

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0043

MECHANISMS UNDERLYING THE DIFFERENTIAL PROCESSING BY MOTOR CORTEX OF REAFFERENCE FROM SLEEP-RELATED TWITCHES AND WAKE MOVEMENTS

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Introduction: Sensory feedback (or reafference) from spontaneous limb twitches during active sleep triggers spindle bursts in the primary motor cortex (M1) of infant rats. In contrast, self-produced wake movements fail to elicit such activity. The neural mechanisms responsible for this differential processing of reafference from twitches and wake movements remain unknown. Here we hypothesized that reafference from wake movements triggers M1 spindle bursts only if it does not match the feedback predicted by the efference copy (or corollary discharge) of the motor command. This would suggest that twitches are distinct from wake movements in that the former are not accompanied by corollary discharge. We tested this hypothesis by manipulating the degree of expected error between efference copy and reafference signals in infant rats.

Methods: We recorded neural activity from the hindlimb region of M1 in unanesthetized, head-fixed infant rats (8-10 days of age). Rats were intraperitoneally injected with either saline or quipazine, a selective 5-HT_{2a} and 5-HT₃ serotonin agonist known to elicit stepping behavior by activating local spinal circuits. Such motor activity is hypothesized not to generate efference copy, so a reafference signal would be always unexpected. Alternatively, a fixed object was placed around the infant's hindlimb to manipulate the degree of expectancy of sensory feedback from self-generated wake movements.

Results: Wake movements elicited by quipazine administration triggered spindle bursts in M1, similar to what is observed during sleep twitches. Placement of a fixed object near a moving hindlimb had a similar "unmasking" effect on M1 activity.

Conclusion: Sensory feedback from wake movements in M1 can be "unmasked" if a) the self-produced movement is not accompanied by corollary discharge, as is perhaps the case with twitches, or b) the resulting reafference does not match the expected feedback predicted by an efference copy.

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0044

SLEEP AND TWITCH-DEPENDENT PURKINJE CELL ACTIVITY ACROSS EARLY POSTNATAL CEREBELLAR DEVELOPMENT.

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Introduction: Sleep is the predominant behavioral state exhibited in infancy. One of the most conspicuous features of sleep in infant mammals is myoclonic twitching of skeletal muscles. This spontaneous activity provides discrete sensory feedback that is considered to be critical for neural plasticity and sensorimotor integration during development. In rats, the cerebellum is integral to sensorimotor integration, but also undergoes extensive postnatal development. Within the first postnatal weeks, Purkinje cells develop massive dendritic arborizations while undergoing major changes in their connections with climbing and mossy fibers. Although the anatomical development of the cerebellum has been thoroughly investigated, little is known about the functional processes involved. Interestingly, despite this nascent circuitry, we have recently shown that rat pups at postnatal day 6 show substantial Purkinje cell activity, including the presence of complex and simple spikes, predominantly during sleep. We also see twitch-dependent Purkinje cell activity, suggesting a mechanism for activity-dependent development of cerebellar circuitry.

Methods: Using 16-channel silicon electrodes (NeuroNexus), we recorded extracellular Purkinje cell activity in unanesthetized, head-fixed rats at 4, 8, and 12 days of age as they cycled between sleep and wake. Nuchal and hindlimb EMG activity were also recorded, and sleep-wake behaviors were concurrently scored by an experimenter.

Results: We found that Purkinje cell activity was state-dependent at all three ages, with the most prominent sleep-dependency occurring at 8 days of age. Also, complex and simple spikes were apparent at all three ages and both forms of activity occurred in close temporal proximity to twitching.

Conclusion: These results indicate that the infant cerebellum exhibits functionally patterned activity during active sleep in close association with twitching. Myoclonic twitches may serve as a critical mechanism by which peripheral sensory and proprioceptive activity is transmitted to the cerebellum to establish the somatotopic mapping required for fine integration of sensory and motor systems.

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0045

GROWTH IMPAIRMENT OF NASAL AIRWAY UNDER INTERMITTENT HYPOXIA DURING GROWTH PERIOD IN RATS

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Introduction: Obstructive sleep apnea syndrome (OSAS) has been reported in children as well as in adults. Children with OSAS show growth retardation of the maxillofacial area, such as macroglossia and micrognathia. Morphological characteristics of maxillofacial region in OSAS patients may be associated with the disturbance of respiratory function which causes intermittent hypoxia (IH) during sleep. However, the detailed basic research has not been done for the relationship between maxillofacial growth and IH in childhood. The aim of this study is to estimate influences of IH on the growth and development of mid-facial area including nasal cavity in growing rats.

Methods: Male 7-week-old Sprague-Dawley rats were divided into 2 groups; the experimental group (n = 5) was underwent IH at a rate of 20 cycles/h (nadir 4% O₂ to peak 21% O₂ with 0% CO₂), and control group (n = 5) was room air breathing. After 3 weeks of IH exposure, maxillofacial structures in both groups were evaluated with the height/width/length of the nasal cavity, the surface area, cross sectional area and volume of rat nasal cavity by using soft X-ray and micro-CT. Data were analyzed statistically using Mann-Whitney U test (P < 0.05).

Results: The experimental group showed a significantly smaller value as compared to the control group in cross sectional area and volume of nasal cavity. Surface area wasn't significantly different but tended to be smaller in the experimental group compared to the control group. The volume was divided by the length of tibia in order to compare the growth of whole body, and it was smaller in the experimental group than the control group.

Conclusion: Data suggested that IH exposure suppresses the growth and development of nasal cavity, to disturb nasal breathing, which may exacerbate the pathogenesis of OSAS.

0046

SKIN TEMPERATURES ACCORDING TO THE SLEEP-WAKE CYCLE IN PRETERM NEONATES

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Introduction: Core and skin temperatures vary in reverse curve among the sleep-wake cycle in adults: wakefulness (W) is characterized by low cutaneous and high internal temperatures (T) in contrast to sleep during which Tcutaneous are higher and Tinternal is lower. This study analyzed whether preterm neonates, whose sleep and thermoregulatory characteristics are very different from those of adults, exhibit similar body temperature differences pattern. In the absence of daytime/nighttime sleep distribution, we compared body T during nocturnal sleep with those of wakefulness episodes after sleep onset.

Methods: A nocturnal PSG (EEGs, EOG, 12 hrs) was performed on 12 preterm neonates (207 ± 10 days postmenstrual age, 1.435 ± 303 g birth mass, 9th night of life). Skin T were measured by infrared thermography on 10 sites (abdominal supposed to be a good indicator of internal temperature, pectoral, shadows of the eyes, thighs, hands and feet) every 5 minutes and averaged over each sleep episode (n = 544, Wakefulness, Active (AS), Intermediate (IS) and Quiet (QS) sleeps).

Results: Distal temperatures differed between the sleep stage: Tfoot increased from W to AS (+0.3°C) to IS and QS (+0.4°C, p always < 0.05); Thand was significantly higher in IS and QS than in W. The same was observed for Tthigh. In contrast, proximal temperatures (pectoral, shadow) and Tabdo did not change during the sleep-wake cycle.

Conclusion: Despite several differences with sleep-wake cycle of adults and even though several neonates still do not have efficient peripheral vasomotor control (involved in skin vasodilation observed at sleep onset as observed in adults), they exhibit similar patterns of distal cutaneous temperatures during the sleep-wake cycle, with higher levels during sleep stages compared to W levels. The fact that Tabdo did not decrease during sleep compared to W in contrast to internal temperature in adults can be explained by the fact that Tabdo could only partly reflect internal temperature.

Support (If Any): ANR-TecSan Project 08-016.

0047

UNVEILING EARLY CHANGES IN NEONATAL SLEEP MICROARCHITECTURE: CONTRIBUTION OF UNANESTHETIZED SURGERY

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Introduction: Stressful events affect neonatal quiet sleep organization. Transitional/indeterminate sleep (TS) changes in early development may also serve as behavioral markers of stress, but have been less well-characterized. We used historic data to determine unanesthetized circumcision's impact on neonatal TS.

Methods: 17 circumcised male (CM) and 6 uncircumcised male (UCM) neonates were monitored through hospital discharge (up to 2.7 days). Infant state was identified from Motility Monitoring System-recorded respiratory and movement patterns. Each continuous bout of Active and Quiet Sleep lasting ≥ 30 minutes qualified as a cycle. TS% and behavioral transitions per cycle-hour were compared between groups, which did not differ on: maternal age, parity, labor anesthetic, delivery or feeding method, or number of recorded sleep cycles. All 5-minute APGAR scores were ≥ 7 .

Results: Neither post-circumcision TS% nor transition density differed from UCM when controlling for age. Circumcised males' TS% ($p = .027$, $d = .69$) and transitions during AS ($p = .001$, $d = 1.03$) increased from pre- to post-circumcision. Uncircumcised males experienced similar, but nonsignificant, changes in TS% and AS transition density ($p = .366$, $d = .52$ and $p = .280$, $d = .56$, respectively). There was no Circumcision*Time interaction. Circumcision explained 20.4% of the variation in TS% ($p = .026$) and 27.3% of the change in transition density ($p = .010$). Transitions during QS, but not AS, were explained by measurement latency from circumcision (22.8%, $p = .041$).

Conclusion: Neonatal TS increased for CM and UCM, but decreased for CM after circumcision. It is not clear whether the TS-circumcision relation is causal. Future research should clarify whether decreases in TS after circumcision result from nonlinear postnatal TS trends, from additional surgical intervention, or from an alternate covariate.

Support (If Any): Data were collected from 1994-1999 under the mentorship of Evelyn B. Thoman, PhD.

0048

DO PRETERM NEONATES SLEEP DIFFERENTLY WHEN THEY ARE BORN SMALL-FOR-GESTATIONAL AGE?

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Introduction: Being born small-for-gestational age (SGA) is a well-known factor of risk for developmental disruptions. However, sleep is of

importance for neurodevelopment but the influence of SGA on sleep is not elucidated. The aim of this study was to investigate their interaction in preterm neonates.

Methods: 12-hour polysomnographies were performed at night 6 (N6) and night 9 (N9) of life in a population of 52 preterm neonates nursed in closed incubators. 2 groups were distinguished: SGA ($n = 11$, gestational age (GA): 29.5 ± 1.7 wk; birthweight (BW): 883 ± 180 g) and adapted-for-gestational age (AGA) ($n = 41$, GA: 29.6 ± 1.2 wk; BW: 1332 ± 283 g). Sleep structure was characterized by total and average durations, the percentages and frequencies of active (AS), quiet (QS) and indeterminate (IS) sleep episodes and wakefulness after sleep onset (WASO). Sleep stability was assessed from sleep stage frequencies.

Results: As regards to sleep structure, differences were highlighted in SGA compared to AGA. At N6, average duration of IS episodes were longer. At N9, total duration, average duration and percentage of AS episodes were higher (401 ± 58 vs. 346 ± 64 min, 26 ± 2 vs. 21 ± 5 min and 64 ± 9 vs. 57 ± 10 %; respectively). Percentage of IS episodes were lower (22 ± 7 vs. 27 ± 6 min; respectively). The frequency of sleep state changes was smaller at N6 and N9 (3.8 ± 0.5 vs. 4.5 ± 0.9 h⁻¹ and 3.6 ± 0.5 vs. 4.2 ± 0.7 h⁻¹; respectively).

Conclusion: During the first days of life, compared to AGA, SGA status changes less sleep state and they do more AS at N9. Our results could contribute to highlight an increase of neurodevelopmental maturation in SGA neonates who could overcome their delay in this way. However, further investigations are required to confirm our assumption.

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0049

A LONGITUDINAL STUDY OF INDIVIDUAL VARIABILITY IN INFANT SLEEP CONSOLIDATION

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Introduction: Over the first year, infant sleep patterns change dramatically from fragmented sleep to consolidated sleep. The aim of this longitudinal study was to investigate the individual variability in consolidation of infant sleep patterns.

Methods: Data were collected from users of a free, publicly available app for the iPhone over 19 months. In the app, users have the ability to record the sleep sessions of their children, including date, start time and duration of the sleep session. Sleep data were collected from 87 children (whose starting age ranged from less than 1 month to 12 months) for whom at least 500 sleep sessions were tracked, for a total of 82,219 sleep sessions. This study was IRB approved and all users provided consent.

Results: While sleep patterns change as infants age and while infants tend to follow similar patterns of sleep development, there can be wide variability in the age at which the transition from fragmented to consolidated sleep occurs and how the transition occurs. Consolidated sleep was exhibited by 13% (6 of 47) of infants at three months, 52% (27 of 52) at six months and 73% (40 of 55) at twelve months. While fragmented sleep was exhibited by 64% at three months, 31% at six months and 23% at twelve months. 23% of infants were in transition between fragmented and consolidated sleep at three months, 17% at six months and 4% at twelve months. Some infants transitioned rapidly to consolidated sleep—nearly overnight—while the median transition time to consolidated sleep occurred over three and a half months with individual variability ranging from days to over six months. The length of the transition period was independent of infant age.

Conclusion: The use of an iPhone app to collect real world data from users was effective in collecting a large longitudinal data set that can capture the transition from fragmented to consolidated sleep. The ma-

jority of infants consolidated their sleep over three and a half months, although significant variability was observed.

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0050

INTELLIGENCE AMONG SCHOOL-AGED CHILDREN (AGE 6-12) IS ASSOCIATED WITH DELTA POWER IN SLEEP

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Introduction: Determining the biological correlates of intelligence represents a potential opportunity to understand and to manipulate the factors that might contribute to cognitive ability. Increasing attention has focused on electroencephalogram (EEG) oscillations during sleep—particularly those in the delta frequency band (0.8-4 Hz)—as playing an essential role in various forms of cognition. We sought to determine if the quantity of EEG delta power during sleep might correlate with intelligence scores of school-aged children.

Methods: The current study performed unattended, home polysomnography in 154 healthy Caucasian and Hispanic children recruited from elementary schools. Following sleep, neuropsychological testing was performed, including intelligence quotient (IQ) from the Wechsler Abbreviated Scale of Intelligence (WASI). Sleep was visually scored according to conventional sleep stages in 30-second epochs. EEG delta power was then calculated for each NREM epoch via discrete fast Fourier transform (FFT).

Results: We examined the potential association between intelligence and sleep by comparing IQ from WASI with the average EEG delta power from NREM sleep epochs for each subject. The odds of having a higher IQ increased with increasing EEG delta power. Specifically, when compared to the 1st quartile of EEG delta power during NREM sleep, the odds of higher IQ progressively increased: the adjusted odds ratio for a higher IQ was 1.28, 1.78, 2.59, for quartiles 2, 3, and 4 respectively, even after adjusting for age, sex, and ethnicity.

Conclusion: Intelligence appears to be greater with increasing EEG delta activity in NREM sleep. This finding raises the importance of considering brain physiology during sleep when determining factors that might contribute to cognitive aptitude of school-aged children. Future directions will seek to determine causal associations between these factors, in order to pursue strategies that might maximize cognitive ability through optimized sleep.

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0051

SLEEP DISRUPTION IMPAIRS BLOOD-BRAIN BARRIER FUNCTIONS

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Introduction: The blood-brain barrier (BBB) is a regulatory interface between the CNS and its peripheral environment. Sleep disruption changes the circadian rhythm as well as absolute concentrations of many cytokines, neurotransmitters, and other hormones. The effects of sleep disruption on BBB function are surprisingly poorly understood. A recent report from Mexico showed that selective REM deprivation increases BBB permeability, but this study with the inverted flower pot method is not controlled for stress. We used several approaches to determine multiple aspects of BBB function after sleep disturbance.

Methods: C57 adult male mice were divided into 5 groups: sleep deprivation (SD) by rotation of a bar randomly and gently at the bottom of the round cage every 30 sec; sleep fragmentation (SF) with bar rotation every 2 min; SF only during the light span; control study with bar rotation during the dark span when mice were active; and non-perturbed naïve controls. The changes of sleep architecture were verified by sleep recording and analyses. Terminal studies were performed 6 days later. BBB permeability was determined by blood-to-brain transfer of sodium fluorescein and albumin, by distribution of FITC-albumin histologically, and by qPCR and western blotting quantification of tight junction proteins as well oxidative stress and inflammatory markers at BBB microvessels. Nutrient transport was determined by in-vivo and in-vitro transport assays and quantification of transporter expression. Stress hormones and cytokines were measured by ELISA in blood samples.

Results: SD for 5 days was sufficient to induce BBB inflammation, decrease occludin and iNOS mRNA, and suppress the expression of several key transporters. This correlated with impaired function of the BBB. SD was a more severe insult than SF, and the effects were dependent of the duration and severity of sleep disturbance.

Conclusion: The BBB is critically involved in neuropathological changes resulting from sleep disruption.

0052

NON-REM DELTA POWER AND AGE ARE ASSOCIATED WITH GLUCOSE METABOLISM DURING WAKEFULNESS

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Introduction: Slow-wave sleep and corresponding delta power (.05- 4 Hz) decline with aging, and are thought to be a marker for cortical reorganization, particularly within the frontal lobes. Thus greater slow-wave sleep across the adult lifespan may promote daytime brain function and cerebral metabolic rate. We examined the association between delta power during NREM sleep and whole brain and regional glucose metabolism during wakefulness in young and middle-aged adults.

Methods: Participants included 54 young and middle-aged adults between the ages of 24-60 (mean age = 38.95; 28 females). Participants were enrolled in studies that included polysomnography, quantitative EEG, and FDG positron emission tomography scans during wakefulness. Relative and absolute estimations of glucose metabolism were collected. Multiple regressions were used to examine the association between delta power and glucose metabolism during wakefulness.

Results: Whole brain absolute glucose metabolism was marginally and positively associated with greater relative delta power, $R^2 = 0.07$, $p = 0.076$. This effect was moderated by age (R^2 change = .114, $p = 0.014$); using a median split, the relationship was significant in older

but not younger participants, $r = 0.53$, $p = 0.008$ (mean age = 47.40). A significant negative relationship was identified between age and relative regional glucose metabolism in the superior frontal gyrus, $t = 4.52$, cluster level FWE corrected, $p < 0.001$. This relationship was no longer significant after accounting for relative delta power. The relationship between relative delta power and metabolism in the superior frontal gyrus, $t = 3.86$, $p = 0.025$, was not significantly moderated by age.

Conclusion: Greater relative delta power during NREM sleep was associated with cerebral metabolic rate during wakefulness, particularly in brain regions important for executive control. Broadly, these results suggest that greater delta sleep may mitigate age-related decreases in daytime cerebral metabolic rate.

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0053

MELATONIN PROMOTES SLEEP BY INHIBITING OREXIN NEURONS

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Introduction: Melatonin is known to promote sleep. Although melatonin inhibits the master circadian controller, the suprachiasmatic nucleus, it is yet unclear whether the sleep promoting effects of melatonin are mediated via its inhibition of the suprachiasmatic nucleus. Since the perifornical hypothalamic (PF-LH) orexin system is a critical wake-promoting system, we asked: Does melatonin promote sleep by inhibiting orexin neurons?

Methods: We designed three experiments in C57BL/6J mice to address this issue. Experiment 1 examined the presence of melatonin receptors on the orexin neurons. Double-label immunofluorescence was used to localize melatonin receptors on orexin neurons. Experiment 2 examined the effects of bilateral PF-LH infusion of melatonin on sleep-wakefulness. Standard sterile surgical protocol was used to implant sleep recording electrodes and bilateral guide cannulas, target toward the orexinergic PF-LH. Melatonin (500 pmol/50 nl/side) was bilaterally microinjected at dark onset and its effect on sleep-wakefulness was examined. On completion, mice were euthanized to localize the injection sites in the orexinergic PF-LH. Experiment 3 examined the effects of melatonin on c-Fos expression in the orexin neurons. Mice were prepared for bilateral microinjections (no sleep recordings) as described above. Melatonin (500 pmol/50 nl/side) was bilaterally infused into the orexinergic PF-LH at dark onset. The animals were euthanized two hour later to examine the presence of c-Fos expression in orexin neurons.

Results: Our results suggest: 1) Orexin neurons expressed MT1 receptors. MT2 receptors were not expressed. 2) Bilateral infusion of melatonin into the orexinergic PF-LH, during the active period, significantly suppressed wakefulness and promoted NREM sleep. REM sleep was unaffected. 3) Bilateral infusion of melatonin into the orexinergic PF-LH significantly reduced the number of orexin neurons with c-Fos immunoreactivity.

Conclusion: Our results that melatonin may act via MT1 receptors to inhibit orexin neurons and promote sleep.

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0054

PHARMACOGENETIC STIMULATION OF THE RED NUCLEUS INFLUENCES MUSCLE TONE DURING RAPID EYE MOVEMENT (REM) SLEEP IN MICE

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Introduction: Rapid eye movement (REM) sleep behaviour disorder (RBD) results from over-exaggeration of muscle activity during REM sleep. Healthy REM sleep is characterized by muscle atonia punctuated by brief, intermittent muscle twitches. Although mechanisms underlying REM paralysis have been identified, mechanisms mediating REM sleep twitches remain unclear. Here, we aimed to determine if the red nucleus (RN)—a region that controls movement—is involved in generating phasic twitch movements during REM sleep. We did this by pharmacogenetically activating RN cells to determine if their stimulation promotes phasic muscle twitch movements in REM sleep.

Methods: The RN of wild-type mice were bilaterally injected with 100–200 nL of an adeno-associated viral (AAV) vector containing an engineered G-protein coupled receptor (AAV-HSYN-hm3D(Gq)-mCherry; DREADD). The administration of clozapine-N-oxide (CNO, 5 mg/kg) stimulates neurons in the RN expressing the DREADD. Sleep-wake behaviour was recorded before and after drug administration, as well as with a saline-control.

Results: Pharmacogenetic stimulation of RN neurons increased phasic twitch activity during REM sleep without causing overt motor behaviors such as in RBD. CNO-induced activation of RN cells caused a 15% increase in masseter muscle activity during REM sleep compared with baseline (i.e., saline) conditions. Increases in twitch activity were most noticeable at the beginning of individual REM sleep episodes, suggesting the RN preferentially controls movement at REM sleep onset. RN activation had no effect on motor activity during NREM sleep, suggesting that it plays a role in mediating phasic movements in REM sleep.

Conclusion: These results show that the RN plays a role in mediating the timing and generation of phasic activity during REM sleep. Disruption in RN function could participate in the pathophysiology of RBD.

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0055

PHARMACOGENETIC MANIPULATION OF RAPID EYE MOVEMENT (REM) SLEEP CIRCUITRY

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Introduction: Rapid eye movement (REM) sleep is characterized by the activation of cortical electroencephalogram (EEG) and loss of muscle tone (atonia). The subcoeruleus (SubC) neurons are hypothesized to generate the motor atonia and cortical activation characteristic of REM sleep. Here we aimed to determine how pharmacogenetic stimulation of SubC neurons impacts the expression of REM sleep.

Methods: To stimulate all neurons in the SubC region, we bilaterally microinjected 200–400 nL of an AAV harboring a modified muscarinic G-protein coupled receptor (AAV-HSYN-hm3D(Gq)-mCherry) into the SubC region of 5 wild type mice. In order to stimulate just glutamatergic neurons, we bilaterally microinjected 200 nL of AAV-HSYN-DIO-hm3D(Gq)-mCherry in 4 vglut2-cre mice. Administration of clozapine-N-oxide (CNO, 5 mg/kg) activated SubC neurons expressing the hm3D(Gq) receptor. Control animals were injected with a viral construct that had no neuromodulatory protein, AAV-HSYN-eGFP.

Results: Consistent with our hypothesis, SubC activation promoted REM sleep, and associated REM sleep phenomena. Specially, we found

that SubC activation triggered episodes of REM-like sleep that sporadically interrupted normal periods of wakefulness. This intervention also increased the average length of REM sleep periods by 200% above normal control conditions (i.e., saline). SubC activation also triggered increases in overall cortical theta activity present in all behavioral states. Controls (i.e., GFP-expressing animals) exhibited none of these behavioral changes. Specific activation of glutamatergic cells in the SubC also promoted REM sleep phenomena (e.g., theta activity), suggesting that a glutamatergic mechanism operating at the SubC is responsible for driving REM sleep.

Conclusion: These results support the hypothesis that the SubC region is involved in controlling the characteristics of REM sleep and that the glutamatergic cells of the SubC mediate the cortical activity of the state.

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0056

OPTOGENETIC INVESTIGATION OF RAPID EYE MOVEMENT (REM) SLEEP CIRCUITRY

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Introduction: It remains unclear which neuronal circuit triggers rapid eye movement (REM) sleep and generates its characteristics (e.g., cortical activation, muscle atonia). The subcoeruleus (SubC) neurons are active during REM sleep and are anatomically well positioned to control both cortical activation and motor atonia. Here we aimed to determine how optogenetics stimulation of these neurons impacts REM sleep expression.

Methods: To precisely control the neuronal activity of the SubC region, we bilaterally infused 200 nL of an adeno-associated viral vector (AAV) containing either a light-sensitive opsin (AAV-hsyn-hChR2(H134R)-eYFP) or an inert reporter protein (AAV-hsyn-eYFP) into the SubC of wild type mice. Animals were instrumented for EEG and EMG recordings. Neurons were stimulated with short blue light pulses (5 ms) at 1 and 10 Hz either independently of behavioral state or specifically during REM sleep. Only animals that had histological verification of ChR2/eYFP expression in the SubC region were used for analysis.

Results: We found that semi-chronic bilateral light activation (i.e., 10-ms on, 90-ms off) of SubC neurons at 10 Hz for 1-hr, but not 1 Hz, triggered REM sleep-like EEG activity (theta, 4–8 Hz) during light stimulation, and increased EEG Theta power by $11 \pm 2\%$ compared to control ($p < 0.05$). More specifically during REM sleep, 10 Hz light stimulation prolonged the duration of REM sleep episodes by almost 3-fold. Similar stimulation of control animals did not change REM sleep duration. Surprisingly, muscle tone was further decreased by $33 \pm 3\%$ during these REM-specific stimulations compared to baseline.

Conclusion: These results support the hypothesis that the SubC region is involved in controlling REM sleep and its associated phenomena.

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0057

SLEEPLESS IS A BI-FUNCTIONAL REGULATOR OF NEURONAL EXCITABILITY AND CHOLINERGIC SYNAPTIC TRANSMISSION UNDERLYING CONTROL OF SLEEP IN DROSOPHILA

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Introduction: We and others previously showed that the SLEEPLESS (SSS) protein upregulates the levels and gating kinetics of Shaker potassium (K) channels to suppress neuronal excitability and promote sleep in *Drosophila*. However, the structural homology of SSS to known antagonists of nicotinic acetylcholine receptors (nAChRs) such as alpha bungarotoxin and lynx1 suggests that SSS may also reduce nAChR activity to facilitate sleep.

Methods: *Drosophila* nAChR activity was reduced by RNAi knock-down of different nAChR transcripts and by feeding flies the nAChR antagonist mecamylamine. Sleep in these animals was measured using the DAM system from Trikinetics. Complex formation between fly nAChRs and SSS was tested by co-transfection and co-immunoprecipitation of *Drosophila* Dalpha3 with SSS in HEK cells. Functional modulation of nAChR activity was determined in ion flux experiments in HEK cells co-transfected with nAChR and *sss* cDNAs. To determine if SSS and its mammalian homologs have similar functions, co-immunoprecipitation experiments were carried out with lynx1, nAChRs and K channels from mouse brain, and sleep was measured in flies in which a lynx1 cDNA was used to replace *sss*.

Results: Pharmacological or genetic suppression of nAChR activity restores sleep to *sss* mutants, suggesting that SSS normally antagonizes nAChRs in flies. This hypothesis is supported by ion flux experiments in which SSS suppresses nAChR activity in transfected cells. This effect may be direct since Dalpha3 and SSS proteins can also be co-immunoprecipitated in transfected cells. The bifunctional role of SSS in regulating K channel and nAChR function appears to be conserved since lynx1 can partially restore normal sleep to *sss* mutants, and lynx1 can form stable complexes with both K channels and nAChRs in transfected cells.

Conclusion: Our data point to a multifunctional role for SSS and its family members in reducing excitability and synaptic transmission in fundamental processes of the nervous system such as sleep.

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0058

OPTOGENETIC EXCITATION AND INHIBITION IDENTIFY A PHYSIOLOGICAL ROLE FOR BASAL FOREBRAIN PARVALBUMIN NEURONS IN CORTICAL GAMMA BAND OSCILLATIONS (GBO) IN FREELY BEHAVING MICE

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Introduction: During wakefulness, the cortical encephalogram (EEG) is characterized by low voltage, high-frequency rhythms such as gamma band oscillations (GBO; 30-80 Hz) required for attention, working memory and sensory processing. While cortical GBO have been extensively studied, the subcortical mechanisms that control GBO are not well understood. Here we study the role of basal forebrain parvalbumin (PV) neurons using optogenetic techniques.

Methods: PV-cre mice were injected bilaterally with either AAV-ArchT-GFP or AAV-ChR2-EYFP into basal forebrain (BF) or thalamic reticular nucleus (TRN). BF mice also received mu-p75 saporin to lesion cholinergic neurons. EEG/EMG electrodes recorded sleep-wake behavior and intracranial microwire assembly recorded single-unit activity. Optical fibers were implanted in BF or TRN for optical stimulation/inhibition of PV neurons. Optical stimulation at frequencies from 2-60 Hz was given for 5 s to study the effect of BF or TRN PV neuronal stimulation on cortical GBO in freely moving mice. Optical inhibition of BF PV cells, before or during 40 Hz audible click trains (500 ms duration, 0.5 ms pulse width, 85 db) were used to test if inhibition of BF PV cells inhibited the 40 Hz cortical acoustic steady state response (ASSR).

Results: Optogenetic stimulation of BF PV neurons reliably entrained cortical GBO particularly at frequencies close to 40 Hz. Lesion of BF cholinergic neurons (60-80% cell loss) did not block this effect (control, $n = 8$ vs saporin, $n = 6$). Bilateral optogenetic inhibition of BF PV neurons reduced 40 Hz ASSR power ($n = 6/8$, 75%). Histological analysis confirmed a strong projection of BF GABAergic PV neurons to TRN. However, unlike BF PV stimulation, optical stimulation of TRN PV cells preferentially enhanced cortical power at 10 Hz not 40 Hz. BF PV neurons identified by short-latency response to optogenetic excitation discharged at beta/gamma frequencies during wakefulness and REM sleep.

Conclusion: BF PV neurons are involved in subcortical control of cortical GBO during wakefulness and REM sleep, likely via direct projections to cortical interneurons. In contrast, TRN PV neurons preferentially entrain cortical oscillations in the spindle frequency (~10 Hz) during slow-wave sleep.

Support (If Any): Dept. of Veterans Affairs; HL095491, MH039683, NS079866.

0059

NEUROANATOMICAL CIRCADIAN CIRCUITS IN HUMANS: EVIDENCE FROM VIRTUAL WHITE MATTER DISSECTIONS WITH DIFFUSION TENSOR IMAGING TRACTOGRAPHY

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Introduction: The neural circuitry of circadian regulating pathways has been demonstrated with viral tracer studies in rats, showing a route from the suprachiasmatic nucleus of the hypothalamus (chief internal circadian pacemaker) projecting to sympathetic nerve fibres in the spinal cord. Sympathetic projections innervate the pineal gland, via the superior cervical sympathetic ganglion in the neck, thereby stimulating secretion of the sleep inducing hormone melatonin. Due to the invasive nature of tracer techniques, a human anatomical homologue circuit remains to be established. This study reports the first findings of in vivo virtual white matter circadian circuit dissections in humans, with non-invasive probabilistic diffusion tensor imaging (DTI) tractography.

Methods: Probabilistic DTI tractography was used to virtually dissect circadian tracts on individual brain scans. Dissections were achieved with the use of a designated seed mask in the optic chiasm, a key anatomical landmark projecting to the suprachiasmatic nucleus. Waypoint masks were drawn manually on the periaqueductal region and the lateral medulla, through which hypothalamic projections to the sympathetic nervous system are known to traverse in humans.

Results: Virtual streamlines were observed in twenty-four human subjects demonstrating a connection from the optic chiasm via a dorsal projection traversing the periaqueductal region and the lateral medulla en route to the spinal cord. Observed streamlines reported are consistent with the topography of circadian projections from the hypothalamus in the rat.

Conclusion: This is the first study to report a candidate circadian homologue circuit in humans. The anatomy of virtual dissections of human circadian pathways reported in this study are consistent with circadian circuits in rats.

Support (If Any): School of Psychology, Bangor University, Gwynedd, UK.

0060

BASAL FOREBRAIN AND THALAMIC RETICULAR NUCLEUS PARVALBUMIN PROJECTIONS STUDIED WITH ANTEROGRADE VIRAL TRANSPORT OF CHANNELRHODOPSIN2-ENHANCED YELLOW FLUORESCENT PROTEIN (CHR2-EYFP) CONJUGATES

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Introduction: The activated cortical EEG evident during wakefulness exhibits gamma band oscillations (GBO, 30-80 Hz), which are essential for cortical processing and abnormal in sleep deprivation and conditions such as autism, schizophrenia and Alzheimer's disease. Optogenetic stimulation of basal forebrain (BF) GABAergic/parvalbumin (PV) neurons in the mouse promotes arousal and entrains cortical GBO activity. The pathways used by BF PV neurons to control cortical arousal may involve direct cortical and/or thalamic projections, e.g., to the thalamic reticular nucleus (TRN), which may, in turn, influence cortical GBO by means of projections to thalamic relay neurons. Thus, we used cell-specific Chr2-EYFP mediated tract-tracing to precisely map the projections of BF and TRN PV neurons.

Methods: Adeno-associated viral vectors expressing Chr2-EYFP were injected into BF or TRN of transgenic mice expressing Cre recombinase under the control of the PV promoter (PV-Cre mice). > 3 weeks later brains were histologically processed, and PV immunohistochemistry performed.

Results: Selectivity of viral expression was confirmed by colocalization of GYFP with PV immunohistochemistry. Transfected fibers were evident in cortex following BF injections, including the frontal and somatosensory cortices. BF PV neurons also projected strongly to the midline thalamus and TRN, particularly its rostro-ventral regions. Following rostral TRN injections, labeling was extensive in the central medial, anteromedial, mediodorsal, laterodorsal, and ventrolateral nuclei, and in more ventral nuclei, including the rhomboid and reuniens nuclei.

Conclusion: Chr2-EYFP-mediated, cell-specific tract-tracing is a useful method to study arousal pathways. Using this method we describe BF GABAergic/PV efferent projections to both the cortex and thalamus, including TRN. In addition, TRN GABAergic/PV neurons project to the midline thalamus. These BF PV projections may be responsible for the modulation of the cortical activated EEG indicative of wakefulness, and particularly GBO. Improved understanding of the neural circuitry controlling cortical arousals will guide therapeutic treatment of related neuropathology.

Support (If Any): Department of Veterans Affairs; NIMH R01 MH039683; NHLBI P01 HL095491; NINDS R21 NS079866.

0061

EXTRACELLULAR ADENOSINE TRIPHOSPHATE INHIBITION OF MOUSE BASAL FOREBRAIN CHOLINERGIC AND GABAERGIC NEURONS VIA BREAKDOWN TO ADENOSINE

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Introduction: Previous work from our lab has found increases in extracellular adenosine (AD) in the basal forebrain (BF) correlate with time awake and infusion of AD causes sleep, implicating AD as a homeostatic sleep factor. We previously showed that AD inhibits BF cortically-projecting cholinergic and GABAergic neurons by inhibiting their glutamatergic inputs. However, the source(s) of extracellular AD is unclear. One possibility is adenosine triphosphate (ATP), released from glia or via neurotransmission, and broken down to AD by the action of extracellular ectonucleotidases. Thus, we hypothesize that ATP inhibits BF neurons via an AD-mediated presynaptic inhibition.

Methods: Coronal brain slices were prepared from young (13-22 d) heterozygous GAD67-GFP knock-in mice. Whole-cell recordings were made using a Multiclamp 700B amplifier. Cholinergic neurons were GFP-negative and identified by their distinctive intrinsic membrane properties (confirmed by posthoc immunohistochemistry for ChAT). GABAergic neurons were identified prior to recording based on their expression of GFP and categorized after recording based on their intrinsic membrane properties.

Results: A 2-3 min bath application of 100 μ M ATP caused a ~35% decrease in spontaneous firing frequency of large-sized GABAergic neurons ($p < 0.01$, $n = 10$), which we have shown to be cortically projecting. Moreover, the inhibitory effect of ATP on these GABAergic neurons was blocked by a specific AD A1 receptor antagonist, 1 μ M CPT ($n = 2$). However, ATP did not change the baseline current of BF cholinergic and GABAergic neurons in 500 nM TTX ($n = 2-13$). Instead, it significantly decreased the frequency of spontaneous excitatory postsynaptic currents (sEPSCs) onto these neurons ($n = 3-6$). This presynaptic inhibition was also completely blocked by CPT ($n = 3-6$). These data suggest that ATP inhibits glutamatergic inputs to BF neurons by degradation into AD which activates A1 receptors.

Conclusion: Increases in extracellular ATP during prolonged waking may cause sleepiness via breakdown to adenosine and an inhibition of cortically projecting cholinergic and GABAergic neurons.

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0062

NEURONAL ACTIVITY DURING SLEEP IN THE CHICKEN

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Introduction: In contrast to mammals, REM sleep in most birds lasts only several seconds when scored based on the conventional polygraphic criteria. The neuronal activity which underlies REM sleep has never been recorded in birds. The aim of this study was to examine neuronal activity of forebrain and brainstem neurons to better understand the nature of REM sleep in the bird.

Methods: EEG, electromyogram, electrooculogram and single neuron activity were recorded in 4 freely-moving domestic chickens (3-4 mo old roosters) across the sleep-wake cycle. Nineteen recorded neurons were located in the dorsal-ventral thalamus, 10 in the lateral hypothalamus and 8 in the midbrain.

Results: Of the 37 recorded neurons, 14 cells (38% of all recorded cells) discharged at the highest rate during waking (W-active), 7 cells (19%) increased their discharge during both waking and REM sleep episodes (W/REM-active), and the remaining 16 cells (43%) were state-indifferent. Of 7 W/REM-active neurons, 2 cells were located in midbrain (dorsal part of the mesencephalic reticular formation), 4 cells in the lateral hypothalamus and 1 cell in the thalamus (tractus occipito-mesencephalus). The average discharge rate during REM sleep was greater than during wakefulness in 3 hypothalamic cells. The W/REM-active cells also increased the firing rates, showing REM-like activation during EEG slow waves without rapid eye movements or muscle tone suppression. The duration of episodes of neuronal activation during REM sleep (scored by polygraphic criteria) and during NREM sleep was comparable.

Conclusion: These findings suggest that 1) REM sleep may occur in birds at the midbrain and the lateral hypothalamus levels without cortical activation; 2) the total amount of REM sleep-like neuronal activity and the duration of single episodes in birds is longer than that scored by conventional polygraphic criteria. This has some similarities to neuronal activity reported during sleep in the "primitive" mammal echidna.

0063

UNILATERAL DEPLETION OF DOPAMINE IN THE DORSOLATERAL STRIATUM INDUCES SLEEP DEFICITS IN THE ABSENCE OF GROSS MOTOR IMPAIRMENT

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Introduction: Dopamine is a catecholamine neurotransmitter with multiple central nervous system roles, including facilitation of locomotion and, putatively, regulation of sleep. Cell body-specific lesions of the striatum and globus pallidus have been demonstrated to increase and decrease sleep propensity in the rat, respectively. Striatal neuron activation is controlled, in part, by dopamine activity. Depletion of dorsolateral striatal dopamine could mimic a "lesioned" striatum, recapitulating sleep deficits and providing a neurochemical basis for the regulation of sleep by the basal ganglia. The modulation of striatopallidal projection neurons by dopamine, and the subsequent putative modulation of cortical pyramidal neuron activation by GABAergic pallidocortical neurons may provide a link between striatal dopamine depletion and sleep disturbance.

Methods: Twenty adult male Sprague-Dawley rats were used in this study. All were implanted with epidural electrodes for sleep recording, while ten received four intracranial injections of 6-OHDA (4×1 mL at 10 mcg/mL) along the rostrocaudal axis of the dorsolateral striatum. The remaining ten received vehicle injection. Sleep was recorded from 0800-2000, followed by two hours of gross motor activity in an open-field apparatus and paw-retraction tests. Dopamine depletion was verified histologically by tyrosine hydroxylase immunoreactivity in the striatum.

Results: Rats with 6-OHDA lesions of the dorsolateral striatum exhibited less overall sleep, and power spectrum analysis of cortical activity indicated reduced slow wave sleep amplitude and higher activation frequency in cortical hemispheres ipsilateral to the lesion. There were no motor differences between groups.

Conclusion: The modulation of striatopallidal projection neurons by dopamine, and the subsequent putative modulation of cortical pyramidal neuron activation by GABAergic pallidocortical neurons may provide a link between striatal dopamine depletion and sleep disturbance. These

findings may be relevant for disease of dopamine dysregulation, including Parkinson's disease and schizophrenia, each of which commonly present with profound sleep disturbances.

0064

TRK B RECEPTOR AGONIST, 7,8-DIHYDROXYFLAVONE, SUPPRESSES SLEEP AND OREXIN LEVELS

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Introduction: Brain-derived neurotrophic factor (BDNF) has been broadly studied for effects on nerve growth, neural protection and mood regulation. BDNF primarily binds on Tropomyosin-receptor-kinase (Trk) B receptors that regulate synaptic strength and plasticity in the mammalian nervous system. 7,8-Dihydroxyflavone (7,8-DHF) is a recently identified small molecular Trk B agonist and has been demonstrated for antidepressive effect, memory consolidation and neuroprotective effect. 7,8-DHF also affects fear response but there is lack of information on how 7,8-DHF affects sleep and sleep regulation.

Methods: Experiment was conducted in mice ($n = 7$ for each group) implanted with electrodes for EEG and EMG recording after 10 days of post surgical recovery and sufficient adaptation to recording cages. After 24 hours baseline recording, 20 mg/kg of 7,8-DHF or vehicle (DMSO) was injected (i.p.) at the beginning of dark phase. Animals were sacrificed on the next day one hour after another dose of treatment, and orexin A was quantified using ELISA kit. Sleep and wake data were evaluated using two way ANOVA on 4 hour data segments. Orexin A data was evaluated by t-test.

Results: Compared with the vehicle (51.38%), total sleep was significantly ($q = 2.98$; $p = 0.035$) decreased in the 7,8-DHF group (41.25%) in the third 4-hour segment, i.e., 8 hours post drug treatment (still in the dark phase). Further analysis indicated that this difference was due to significant ($q = 3.077$; $p = 0.03$) decrease of NREM sleep (36.54% in 7,8-DHF vs. 45.75% in vehicle) but not REM sleep (4.71% in 7,8-DHF vs. 5.62% in vehicle). Interestingly, hypothalamic level of orexin A was also significantly ($t = 2.616$, $p = 0.017$) decreased in the 7,8-DHF group (97 pg/mg in 7,8-DHF vs. 132 pg/mg in vehicle).

Conclusion: 7,8-DHF suppressed NREM sleep in a later dark phase but suppressed orexin A early phase. More work needs to be done to determine the relationship between 7,8-DHF induced changes in orexin and sleep.

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0065

IDENTIFYING THE NEURAL PATHWAYS THAT MEDIATE CORTICAL AROUSAL TO HYPERCAPNIA

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Introduction: Recently, we reported that glutamatergic signaling in the lateral parabrachial area (LPB) regulates cortical arousals to hypercapnia (Kaur et al., 2013). Anterograde projection patterns of the LPB suggest that these arousals may be mediated through forebrain structures such as- the lateral hypothalamus (LH), amygdala (AMYG), basal forebrain (BF) projecting to cortex. However, the specific functions of these pathways in hypercapnic arousals remain unclear.

Methods: To model cyclic hypercapnia as seen during sleep apnea, we investigated EEG arousals to 10% CO₂ given for 30 s every 300 s (repeated CO₂ arousals- RCA). To investigate the role of orexinergic sig-

naling in the LH, we examined RCA in mice with disrupted expression of both orexin 1 and orexin2 receptor genes (OXRTD; $n = 4$) and in wildtype (WT) littermates ($n = 3$). In another set of experiments, we bilaterally lesioned the AMYG of WT mice ($n = 4$) using 20-30 nl of 5% ibotenate and compared the cortical arousals to RCA in lesioned vs. intact mice.

Results: Both OXRTD and WT mice had similar latencies of cortical arousal to hypercapnia (18 ± 1.0 s and 17 ± 2.3 s respectively). On the other hand, AMYG lesioned mice had doubled latency to hypercapnic arousal (35 ± 7.2 s) compared to intact mice (15 ± 2.8 s), and in 20% of trials, AMYG-lesioned mice showed no arousal to hypercapnia.

Conclusion: These results suggest that orexinergic signaling is not necessary for cortical EEG arousals to hypercapnia, but the roles of other LH populations require further investigation. However, the AMYG does appear necessary for hypercapnic arousals, perhaps via projections to BF and cortex.

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0066

CHRONIC INTERMITTENT HYPOXIA AND HYPERCAPNIA, AN ANIMAL MODEL FOR OBSTRUCTIVE SLEEP APNEA, ALTERS A PATHWAY FROM THE HYPOTHALAMIC PARAVENTRICULAR NUCLEUS TO PARASYMPATHETIC CARDIAC NEURONS IN THE BRAINSTEM

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Introduction: Patients with obstructive sleep apnea (OSA) have an increased risk of cardiovascular diseases. The mechanisms of these cardiovascular diseases likely include diminishing cardioprotective parasympathetic activity to the heart due to inhibition of excitatory inputs to cardiac vagal neurons (CVN) in the brainstem. One important excitatory pathway to CVNs originates from the hypothalamic paraventricular nucleus (PVN). We hypothesized that chronic intermittent hypoxia and hypercapnia (CIHH) inhibits the glutamatergic neurotransmission from the PVN to CVNs.

Methods: In an initial surgery the fluorescent tracer rhodamine was injected into the pericardial sac of Sprague-Dawley rats to retrogradely label CVNs. Lentivirus vector that drives expression of channelrhodopsin (ChR2) was injected into the PVN to express ChR2 in hypothalamic PVN neurons and fibers that project to CVNs. On the day of the experiments a single slice of the medulla was obtained and synaptic events in CVNs were studied using whole cell patch-clamp techniques. A pulse of laser light photoactivated ChR2 PVN fibers and a glutamatergic synaptic neurotransmission to CVNs. We compared the glutamatergic responses in CVNs from control rats and rats exposed to 4 weeks of CIHH.

Results: Glutamatergic currents in CVNs evoked by photostimulation of PVN fibers were diminished following CIHH. Acute hypoxia and hypercapnia (H/H) did not significantly alter glutamatergic neurotransmission to CVNs evoked by optogenetic activation of PVN fibers in control animals, however, H/H inhibited these currents in CIHH animals. PVN-evoked glutamatergic neurotransmission was enhanced post H/H in control animals, but not in CIHH animals.

Conclusion: The PVN excitatory pathway to CVNs is diminished in CIHH animals under both normoxic conditions and during and following acute H/H. This would elicit a reduced parasympathetic activity to the heart and an enhanced risk of adverse cardiovascular events in OSA.

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0067

CHRONIC INTERMITTENT HYPOXIA/HYPERCAPNIA DIMINISHES EXCITATORY GLUTAMATERGIC AND INCREASES INHIBITORY GABA NEUROTRANSMISSION TO PRE-MOTOR CARDIAC VAGAL NEURONS

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Introduction: Obstructive sleep apnea (OSA) has been identified as a potential independent risk factor for the development of hypertension, coronary artery disease and arrhythmias. Patients suffering from OSA experience elevated blood pressure and heart rate, in part, due to an imbalance in the autonomic nervous system i.e., heightened sympathetic and diminished parasympathetic activities. The parasympathetic control of heart rate arises from pre-motor cardiac vagal neurons (CVNs) located in nucleus ambiguus (NA) and dorsal motor nucleus of the vagus (DMV).

Methods: The mechanisms underlying diminished parasympathetic control of heart rate were investigated by studying the changes in synaptic neurotransmission (glutamate, GABA and glycinergic) to CVNs in response to chronic intermittent hypoxia and hypercapnia (CIHH), a characteristic feature of OSA. Retrogradely labeled CVNs were identified in an in-vitro brainstem slice preparation obtained from adult rats exposed either to air or CIHH for 4 weeks. Synaptic events were recorded using whole cell voltage clamp technique and statistical significance was tested using unpaired t-test.

Results: The frequency of glutamatergic excitatory postsynaptic currents (EPSCs) to NA and DMV CVNs was reduced by 35% and 45% respectively in CIHH rats compared to control animals ($p < 0.01$). Also, the amplitude of glutamatergic EPSCs to DMV neurons in CIHH rats was 25% lower than those in air exposed rats ($p < 0.05$). On the other hand, the frequency of GABA inhibitory postsynaptic currents (IPSCs) to NA in CIHH rats was 50% greater than air exposed rats ($p < 0.05$). There were no significant changes in glycinergic inhibitory neurotransmission to CVNs observed between CIHH and control groups.

Conclusion: A significant reduction in excitatory glutamate and an increase in inhibitory GABAergic neurotransmission to CVNs in CIHH rats would result in less vagal outflow to the heart and a subsequent increase in heart rate and increased risk of adverse cardiovascular events that occur in OSA.

Support (If Any): NIH-49965.

0068

CHRONIC INTERMITTENT HYPOXIA AND HYPERCAPNIA, AN ANIMAL MODEL FOR OBSTRUCTIVE SLEEP APNEA, ALTERS A GABAERGIC PATHWAY TO PARASYMPATHETIC CARDIAC NEURONS IN THE BRAINSTEM

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Introduction: Patients with sleep-related disorders, including obstructive sleep apnea (OSA) have an increased risk of cardiovascular diseases. REM sleep further increases the risk of adverse cardiovascular events by diminishing cardioprotective parasympathetic activity to the heart. The mechanisms underlying REM sleep-related reduction in parasympathetic activity include activation of inhibitory input to cardiac vagal neurons (CVNs) in the nucleus ambiguus originating from the lateral paragigantocellular nucleus (LPGi), a nucleus which plays a role in REM sleep control. I hypothesize that chronic intermittent hypoxia and hypercapnia (CIHH), an animal model of OSA, inhibits cardioprotective activity of CVNs via alterations in the pathway from the LPGi to CVNs.

Methods: In an initial surgery the fluorescent tracer rhodamine was injected into the pericardial sac of Sprague-Dawley rats to retrogradely label CVNs. On the day of experiment a single slice of the medulla that included the nucleus ambiguus and the LPGi was obtained and identified CVNs were studied using whole cell patch-clamp technique. Square wave current injections were applied to evoke GABAergic pathways originating from the LPGi to CVNs. We compared GABAergic current in CVNs evoked by electrical stimulation of the LPGi in control rats and rats exposed CIHH.

Results: GABAergic current in CVNs evoked by stimulation of the LPGi was enhanced following 4-weeks CIHH. Acute hypoxia and hypercapnia (H/H) resulted in an inhibition of LPGi-evoked GABAergic current in both control and CIHH animals. The synaptic responses recovered to normoxic levels post H/H in control animals but were enhanced post H/H in CIHH male animals. Orexin inhibited the synaptic responses in control animals but did not elicit any changes in CIHH animals.

Conclusion: My results show cardioprotective parasympathetic activity to the heart is diminished in animals exposed to CIHH due to an exaggerated inhibitory pathway to CVNs.

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0069

EFFECT OF SEROTONIN ON PROFOUND HYPOXEMIA IN SLEEP APNEA: A CROSS-SECTIONAL STUDY OF DEPRESSED OSA PATIENTS

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Introduction: Sleep apneic episodes often result in blood oxygen desaturation. The degree of oxygen desaturation might be dictated by the arousal mechanism regulated by central serotonergic chemoreceptor located in the brain stem. In patients with relatively decreased serotonergic activity, lack of or diminished response to temporarily rising CO₂ during apnea may result in more prolonged sleep apneic episode and subsequently more profound oxygen desaturation.

Methods: Patients with both depression and obstructive sleep apnea (OSA) were studied. We examined the presence of profound hypoxemia (oxygen saturation below 70%) during overnight polysomnogram. This was compared between two groups divided based on the use of serotonergic drug(s) (SSRI and/or SNRI).

Results: One hundred seventy nine patients with depression and OSA were identified. 107 were on SSRI/SNRI (SS: mean age 51, BMI 36, AHI 14.3) and 72 were not on SSRI/SNRI (NS: mean age 50, BMI 36, AHI 14.2). In SS group only 1 out of 107 subjects had profound hypoxemia whereas 6 out of 72 NS group had profound hypoxemia (0.9% vs. 8.3%, Fisher's Exact test, $p < 0.05$). Age, gender, BMI, AHI and proportion of REM were not significantly different between two groups. However, Epworth Sleepiness Scale (ESS) was significantly higher in serotonergic drug group (11.1 vs. 9.6 vs., $p < 0.05$).

Conclusion: Among patients with depression and OSA, significantly more patients who were not taking serotonergic drug (NS) had profound hypoxemia compared to those taking serotonergic drug (SS). More profound hypoxemia in NS group can be explained by relative paucity of serotonergic activity resulting in diminished arousal response to apneic episode possibly prolonging the apneic episode and further deepening the level of oxygen desaturation. Future research on pathophysiological mechanism of profound hypoxemia from OSA, and REM-related hypoventilation and the potential use of serotonergic agonist in those patients population might be warranted.

0070

CANNABINOID TYPE 1 AND TYPE 2 RECEPTOR ANTAGONISTS PREVENT ATTENUATION OF SEROTONIN-INDUCED REFLEX APNEAS BY DRONABINOL IN SPRAGUE-DAWLEY RATS

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Introduction: The prevalence of obstructive sleep apnea (OSA) in Americans is 9%. Increased afferent vagal activation is implicated in OSA by reducing upper airway patency and producing apnea via activation of serotonin (5-HT) receptors in the nodose ganglia. Vagal afferents are inhibited by cannabinoid type 1 (CB₁) receptors. The role of cannabinoid type 2 (CB₂) receptors is unknown. We previously showed that local injections of dronabinol, a CB₁ and CB₂ receptor agonist, into the nodose ganglia reduced 5-HT-induced reflex apneas. To determine whether CB₁ or CB₂ receptors are involved in dronabinol's attenuating effect, we pre-treated rats with either CB₁ (AM251) or CB₂ (AM630) receptors.

Methods: Adult male Sprague-Dawley rats were anesthetized, injected intraperitoneally with either AM251 or AM630 (5 mg/kg), or with vehicle (15% DMSO in PBS), and instrumented with a piezoelectric strain gauge to monitor respiratory pattern. Serotonin (12.5 µg/kg) was intravenously infused (PBS 0.35 ml/kg) into a femoral vein to induce reflex apnea. After baseline recordings, the nodose ganglia were exposed and 5-HT-induced reflex apneas were recorded to confirm that the nerves remained functionally intact. Dronabinol (100 µg/5 µl sesame oil) was injected into each nodose ganglion and 5-HT infusion was repeated.

Results: Prior to dronabinol injection, there were no significant differences in 5-HT-induced reflex apneas before or after surgery in the CB₁ (AM251), CB₂ (AM630), and vehicle groups. In the vehicle group, dronabinol injections reduced 5-HT-induced reflex apnea duration. In contrast, dronabinol injections into nodose ganglia of the CB₁ or CB₂ groups did not attenuate 5-HT-induced reflex apnea duration.

Conclusion: Systemic pre-treatment with CB₁ or CB₂ receptor antagonist prevented 5-HT-induced reflex apnea attenuation by locally-injected dronabinol in the nodose ganglia. These findings underscore the therapeutic potential of dronabinol in the treatment of OSA and implicate participation of both CB receptors in dronabinol's apnea suppression effect.

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0071

HYPOCRETIN-1 (OREXIN-A) PREVENTS APNEA-INDUCED HIPPOCAMPAL NEURODEGENERATION

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Introduction: Recent studies suggest that hypocretin (Hcrt) is neuroprotective under pathological conditions. For example, Hcrt has been shown to promote cortical and hypothalamic neuronal survival when ischemia and hypoxia are present. Using the rat model of obstructive sleep apnea, we hypothesized that Hcrt, acting as a neuroprotective agent, would prevent apnea-induced apoptotic damage to hippocampal CA1 neurons.

Methods: Experiments were performed on alpha-chloralose-anesthetized, flaxedil-immobilized adult rats. Two groups of rats (Hcrt-1-treated and non-treated) were subjected to recurrent apnea (via ventilatory arrest, nadir SpO₂ = 60%) while a third group of control rats were respired at normal oxygen levels for an equivalent period (2 hr). Hcrt-1 was

administered (30 ug/kg, i.v.) 15 min prior to the initiation of recurrent apnea. Following a 2-hr period of recurrent apnea (for Hcrt-1-treated and non-treated groups) or normoxia (for the control group), the animals were perfused for immunohistochemical processing of the hippocampus. Immunostaining with the poly(ADP-ribose) polymerase-1 (PARP-1) antibody was performed to determine the presence of DNA strand breaks within hippocampal CA1 neurons.

Results: The apneic, non-treated rats exhibited abundant PARP-1-positive CA1 neurons. Dense PARP-1 immunoreactivity was present within the nucleus of individual cells; their cytoplasm was devoid of any PARP-1 immunoreactivity. In contrast, in Hcrt-1-treated rats, only a few cells exhibited weak traces of PARP-1 immunoreactivity, which was similar to that present in normoxic animals.

Conclusion: The present data provide evidence that recurrent episodes of apnea result in the development of neurodegenerative processes in hippocampal CA1 neurons and that Hcrt-1 is able to prevent the apnea-induced DNA damage of CA1 neurons. Accordingly, we suggest that Hcrt-1 has the capacity to function as a potent neuroprotective agent vis-à-vis apnea-induced neurodegeneration, which supports the Survival Theory of the Functioning of the Hypocretinergic System.

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0072

OPTOGENETIC DISSECTION OF THE MCH SYSTEM: IMPLICATIONS FOR SLEEP-STATE MODULATION

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Introduction: The hypothalamus consists of intermingled inhibitory and excitatory neural circuits. Their activity correlates with one or more vigilance states, including wakefulness, non-Rapid Eye Movement (REM) sleep and REM sleep. Recent evidence suggests that neurons expressing Melanin-Concentrating Hormone (MCH) have a sleep-promoting action; however, their selective modulation of NREM or REM sleep states remains unclear.

Methods: To investigate the specific role of MCH neurons, we genetically targeted the expression of activatory (ChETA, SSFO) and inhibitory (eNpHR3.0) optogenetic tools to MCH neurons using a new MCH::Cre mouse model to reliably control their activity in vitro and in vivo.

Results: Using real-time EEG/EMG detection of vigilance states, we found that bilateral optical activation of MCH neurons during NREM sleep increased the probability of NREM-to-REM sleep transitions, while MCH neuron activation during REM sleep extended REM sleep duration in ChETA animals compared to EYFP-expressing controls. These results were confirmed by SSFO activation of MCH neurons in vivo. In contrast, we showed that optogenetic silencing of MCH neurons during REM sleep significantly reduced theta rhythm amplitude concomitant to an increase of slow theta range (3 to 5 Hz) amplitude. Using an unbiased automatic detection of these naturally-occurring slow theta events during REM sleep, we further found that silencing of MCH neurons significantly increased their number in NpHR3.0 animals compared to EYFP-expressing controls. Finally, we demonstrated that optical activation of MCH terminals induced fast GABAA-mediated inhibitory currents in local wake-promoting histaminergic neurons, an effect that is partly mediated by the release of MCH peptide.

Conclusion: Collectively, these results support a causal role for MCH neurons in the onset and maintenance of cortical REM sleep in the mammalian brain.

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0073

INCREASED DAYTIME SLEEP IN A UNILATERAL NONHUMAN PRIMATE MODEL OF PARKINSON'S DISEASE: TREATMENT WITH A NOVEL NEUROTROPHIC FACTOR

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Introduction: Parkinson's disease (PD) is commonly characterized by progressive motor impairment, but PD patients also show non-motor pathologies including changes in sleep physiology, with excessive daytime sleep being fifteen-fold more prevalent in PD patients than age-matched controls. Monkey models of PD, treated with dopamine neurotoxins, also show increased daytime sleep. However, there are reports that sleep problems manifest very early in PD, even before motor symptoms, but there have been no reports of sleep problems in animal models of early stage PD.

Methods: To explore this, 30 female rhesus monkeys, living in large group housing pens, were treated with a low dose intracarotid injection of the dopamine neurotoxin, MPTP. Sleep was assessed from minute-by-minute activity recorded by a collar-worn omnidirectional accelerometer and calculated using a previously reported algorithm defining monkey sleep as 0 activity counts for at least 12 min. Sleep was assessed in two week blocks before MPTP, 3-6 weeks after MPTP, and 8-12 weeks after treatment with 3 monthly intraputamenal infusions of a variant form of human neurturin (NRTN), produced to have less binding within the brain to extracellular heparin sulfated proteoglycans so it would diffuse greater distances.

Results: Low dose MPTP led to a mild unilateral impairment of motor function, but daytime sleep duration increased from 91 ± 10 min/day to 211 ± 22 min/day, p < 0.001, sleep bouts increased significantly, p < 0.001, and latency to wake increased significantly, p = 0.05. All daytime sleep parameters decreased after three intraputamenal infusions of the NRTN variant, N4, p = 0.02, 0.06 and 0.02 respectively (n = 5 monkeys), whereas monkeys receiving vehicle infusions or the neurotrophic factor GDNF showed no decrease in daytime sleepiness.

Conclusion: Daytime sleep increases significantly even in an early stage monkey model of PD created by a lesion of dopamine neurons. The NRTN variant, N4, may be effective therapeutically in treating daytime sleepiness in PD.

0074

LONGITUDINAL SLEEP PHENOTYPE CHARACTERIZATION OF THE MITOPARK MOUSE, AN ANIMAL MODEL WITH PROGRESSIVE PARKINSONISM

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Introduction: Excessive daytime sleepiness (EDS) can affect 20-50% of patients with Parkinson's disease (PD), while the pathological mechanism involved in EDS is unknown. Current animal models have failed to replicate characteristics of PD. A MitoPark mouse is a new genetic PD

model with a tissue-specific respiratory chain deficiency in midbrain DA neurons. MitoPark mice have been validated to show the progressive development of key PD features. We therefore evaluated age-dependent changes in sleep and circadian phenotypes of MitoPark mice.

Methods: Adult male mice ($n = 8$ each for control and MitoPark mice) underwent surgery for EEG/EMG electrodes and E-mitters. Data acquisition was performed at 10 (absent), 15 (mild), 20 (moderate), and 25 (severe) weeks of age. Sleep deprivation was performed after one full day of baseline by gentle handling. Another set of mice was kept under constant dark conditions for 3 weeks from 11 and 21 weeks of age.

Results: MitoPark mice at different ages were placed into a new cage and the locomotor activity was recorded. MitoPark mice showed age-dependent decrease of locomotion, starting from about 15 weeks, consistent with the results previously reported with the open-field measures. Surprisingly however, there was no difference between control and MitoPark mice in the spontaneous locomotor activity through the 24 hours on the day of baseline in all ages examined, suggesting that MitoPark mice show significantly decreased exploratory activity when in the new environment. MitoPark mice had normal amounts and natural diurnal distributions of wakefulness and sleep in the 12:12 LD condition at 10, 15, and 20 weeks of age. There was also no difference in sleep rebound in responses to the 6-hour sleep deprivation, but locomotion during sleep deprivation was significantly reduced. At 25 weeks old, significant sleep fragmentation and a decrease of amount spent in NREM sleep during light periods occurred in MitoPark mice. There was no change in the circadian rhythm in the absent-mild movement severity. The circadian rhythm in the moderate-severe movement severity and vigilance changes during exploratory activity in the new environment are currently under investigation.

Conclusion: Sleep abnormalities (i.e., fragmented sleep/wake patterns) were observed in the MitoPark mice at 25 weeks old only when severe movement abnormalities occurred. Further studies are needed to identify if these sleep abnormalities are homologues to those in human PD and/or merely secondary to the movement abnormalities seen in advanced stage of the disease.

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0075

CHRONIC SLEEP RESTRICTION INCREASES MITOCHONDRIAL SIZE IN CORTICAL PYRAMIDAL NEURONS OF ADOLESCENT MICE

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Introduction: Consistent with higher energy demand in wake than in NREM sleep, mitochondrial respiratory activity increases in cerebral cortex during wake. Mitochondria, however, are more than metabolic hubs, and by forming complex intracellular networks can regulate calcium homeostasis and synaptic plasticity. These networks undergo constant morphological changes that are believed to be essential for the maintenance of healthy mitochondria. Here we use electron microscopy to assess how sleep and prolonged wake affect mitochondrial number and size.

Methods: Somatic mitochondria were examined in layer II pyramidal neurons (20 cell bodies/mouse) of YFP-H adolescent mice frontal cortex (P30) after: i) 6-8 hrs of sleep ($n = 4$ mice, 3532 mitochondria); ii) 6-8 hrs of acute sleep deprivation ($n = 4$ mice, 3817 mitochondria); iii) 5 days of chronic sleep restriction (sleep reduced to $\sim 30\%$ of baseline values) enforced using forced locomotion and exposure to novel objects ($n = 5$ mice, 4390 mitochondria); iv) more than 32 hrs of recovery sleep after chronic sleep restriction ($n = 4$ mice, 3620 mitochondria).

Results: Cortical neurons showed an increased proportion of cytoplasm occupied by mitochondria after chronic sleep restriction relative to sleep.

While mitochondrial density did not change across experimental conditions, absolute mitochondrial size did. Specifically, in chronic sleep restriction a shift of the entire mitochondrial population toward bigger sizes was observed relative to sleep ($p = 0.0022$), together with the presence of extra large mitochondria. Some of these modifications persisted even after several hours of recovery sleep. A trend toward larger mitochondrial size was also observed after acute sleep deprivation relative to sleep, but it did not reach statistical significance.

Conclusion: In the frontal cortex of adolescent mice, excitatory neurons increase the size but not the number of their entire mitochondrial population after chronic sleep restriction, presumably in response to higher energy need due to increased neuronal activity. These mitochondrial changes persist after many hours of recovery sleep.

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0076

VIP NEURONS IN THE SUPRACHIASMATIC NUCLEUS AND THE AMPLITUDE OF REST-ACTIVITY RHYTHMS IN OLDER HUMANS

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Introduction: Aging is associated with changes in circadian function, which are aggravated in Alzheimer's disease (AD). In model organisms, the suprachiasmatic nucleus (SCN) plays a key role in driving circadian rhythmicity. However, whether interindividual differences in SCN integrity are an important determinant of differences in circadian rhythmicity in older humans is unknown. In this study, we investigated whether the parameters of circadian rest-activity rhythms in older humans are associated with cell counts in specific neuronal populations in the SCN.

Methods: We collected up to 10 days of actigraphy data from 17 older adults with and without Alzheimer Disease (mean [SD] age 89.6 [5.5]) participating in the Rush Memory and Aging Project, a longitudinal cohort study of the common conditions of aging. We performed empirical mode decomposition analysis to estimate circadian activity rhythms. Upon death (which occurred a mean [SD] of 9.0 [4.5] months after actigraphy), post-mortem hypothalamic blocks from these subjects were sectioned and stained immunohistochemically for vasopressin (AVP) and vasoactive intestinal peptide (VIP). Numbers of VIP neurons in the ventrolateral and AVP neurons in the dorsomedial portions of the SCN were counted stereologically.

Results: There was a significant ($p < 0.008$) positive correlation between the number of VIP neurons in the ventrolateral SCN and circadian amplitude. By contrast, there were no correlations with any circadian measure and the number of AVP neurons in the dorsomedial compartment. AD subjects had significantly delayed activity acrophases and nadirs in comparison to healthy controls, but diagnosis of AD was not a significant predictor of circadian amplitude or SCN cell numbers.

Conclusion: The retinorecipient VIP neurons are important for maintaining the amplitude of rest-activity rhythms in older humans. Loss of these neurons with the fragmentation of sleep previously found in AD patients may underlie their inability to maintain a normal angle of phase entrainment.

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0077

CEREBRAL SMALL VESSEL DISEASE AND ACTIGRAPHICALLY MEASURED CIRCADIAN RHYTHM AND SLEEP: A POPULATION-BASED STUDY

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Introduction: Stroke and brain injury can lead to changes in sleep and the circadian rhythm. Cerebral small vessel disease is a common type of cerebrovascular disease in elderly persons. White matter lesions and cerebral microbleeds are markers of subclinical cerebral small vessel disease on magnetic resonance imaging (MRI). We investigated whether small vessel disease is related to circadian rhythm and sleep in the general population.

Methods: This study is conducted in the Rotterdam Study, a population-based cohort study of middle-aged and elderly persons. A total of 1031 persons (age 58.8 ± 7.7 , mean \pm standard deviation) underwent brain MRI scanning and participated in our actigraphy study. Cerebral small vessel disease was visualized on MRI scans as white matter lesions (ml) and cerebral microbleeds (presence). Sleep and the circadian activity rhythm were measured objectively with actigraphy to estimate sleep duration, sleep onset latency (SOL) and wake after sleep onset and to calculate the day-to-day stability and fragmentation of the activity rhythm. The circadian rhythm and sleep variables were standardized to facilitate interpretation. We used linear regression adjusted for sex, age, body mass index, activities of daily living, antihypertensives or lipid lowering medication, systolic blood pressure, employment, smoking, cholesterol, myocardial infarction and, only for white matter lesions, intracranial volume.

Results: White matter lesions were related to more fragmentation of the circadian activity rhythm ($b = 0.01$, $p = 0.01$), while we observed a trend for cerebral microbleeds and lower stability ($b = -0.17$, $p = 0.051$).

Conclusion: White matter lesion load and presence of cerebral microbleeds are related to more disturbed circadian rhythms. Although this study cannot show directionality of effects, it suggests that even subclinical brain damage can impair the circadian rhythm.

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0078

DIFFERENTIAL CHANGES IN NREM SLEEP AMOUNTS AND STROKE OUTCOME AFTER PRE-CONDITIONED ISCHEMIA: INFLUENCES OF Bmal1

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Introduction: Insufficient sleep worsens stroke outcome and recovery. Independent of sleep, stroke outcome and recovery is improved by pre-exposure to ischemia. Here, we investigate the combined influences of Bmal1, a gene known to alter daily sleep amounts, and remote ischemia (pre-conditioning) on stroke outcome and recovery in mice.

Methods: Male wild-type (WT) and Bmal1 knockout (KO) mice received EEG/EMG tether implants for 24 h of baseline recording three weeks later. Afterwards, remote or sham ischemia was performed by

tourniquet of the left femoral artery across two 10 minute intervals separated by 10 minutes of release. This was followed by a 72 h EEG/EMG recording and subsequent occlusion of the middle cerebral artery for 1 h (MCAO; $n = 2-5$ /genotype and ischemia). After another 72 h EEG/EMG recording, mice were sacrificed and a tetrazolium chloride (TTC) stain was performed on 0.5 mm-thick coronal brain sections to determine infarct volume.

Results: At baseline, Bmal1 KOs had $6.0 \pm 1.7\%$ more daily NREM sleep and more sleep-wake fragmentation vs. WT (one-way ANOVA; $p < 0.05$). Mice exposed to remote ischemia had more NREM sleep and sleep-wake fragmentation vs. sham controls (three-way ANOVA, ischemia; $p < 0.05$). MCAO further altered sleep-wake fragmentation (three-way ANOVA, stage; $p < 0.05$). Overall, the sleep-wake phenotypes of WT were more sensitive to MCAO with or without remote ischemia compared with Bmal1 KOs (three-way ANOVA, genotype; $p < 0.05$); NREM sleep increased by $18.2 \pm 0.1\%$ from baseline levels following MCAO in pre-conditioned WT (post-hoc paired t-tests; $p < 0.05$). Infarct volumes were largest in the forebrain ($+2.58-1.58$ from bregma) for all mice. Infarct volumes were larger in Bmal1 KOs vs. WT (repeated-measures ANOVA, genotype; $p < 0.05$) and in sham vs. pre-conditioned mice (repeated-measures ANOVA, ischemia; $p < 0.05$).

Conclusion: This study points to reciprocal relationships between sleep and stroke regulatory processes at physiological and molecular levels.

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0079

SLOW WAVE ACTIVITY PERSISTS IN SUPERFICIAL CORTICAL LAYERS DURING REM SLEEP

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Introduction: During REM sleep in humans, conscious experience is disconnected from the external environment. Though the mechanism of sensory disconnection is unknown, it is likely triggered by the absence of several neuromodulators that regulate stimulus-evoked signaling in wake. In the cerebral cortex, neuromodulatory innervation and post-synaptic receptor expression vary across superficial and deep layers, leading to the possibility that neuronal activity in specific layers may be altered in REM sleep. To test this hypothesis, we performed chronic 24-hr recordings in freely moving mice and studied cortical laminar activity patterns during natural sleep.

Methods: Mice ($n = 6$) were implanted with 16-channel silicon laminar probes in sensorimotor cortex. Local field potentials (LFPs) and neuronal activity were recorded continuously along with epidural EEG and EMG. Sleep was manually scored offline in 4-sec epochs according to established criteria.

Results: We found that the overall activity pattern in deep and superficial layers diverged during REM sleep. Whereas deep layers exhibited tonic neuronal activity and low amplitude, high frequency LFP activity, neuronal activity in superficial layers was interrupted by local periods of silence that were accompanied by slow waves (0.5-4 Hz) in the LFP. Though these superficial slow waves had lower amplitude and decreased incidence relative to those occurring in NREM sleep, spectral analysis revealed a well-defined peak in slow wave activity (SWA) in superficial layers during REM sleep. Current source density analysis confirmed that currents in the SWA range originated predominantly in superficial layers.

Conclusion: These findings suggest that neuronal subpopulations in cortex are not uniformly active during REM sleep. We hypothesize that periods of neuronal silence in superficial layers may disrupt recurrent activity between sensory and higher order cortical regions and hence may contribute to sensory disconnection.

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0080

TWO DISTINCT SYNCHRONIZATION PROCESSES IN THE TRANSITION TO SLEEP: A HIGH-DENSITY EEG STUDY

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Introduction: It is now well established that sleep occurs and can be regulated locally. The aim of the present study was to assess local changes in slow waves in the course of the falling asleep period. Specifically, we intended to determine how their origin, cortical distribution and other characteristics evolve in the transition from wakefulness to sleep.

Methods: Six healthy participants (3 males, age 28 ± 5.7) undergoing overnight high-density EEG recordings (256 electrodes) were awakened at 15-30 minute intervals. 141 falling asleep periods were analyzed at the scalp and source level.

Results: The number and amplitude of slow waves followed two dissociated, intersecting courses during the transition to sleep: slow wave number increased slowly at the beginning and rapidly at the end, while amplitude at first increased rapidly and then decreased linearly. Most slow waves occurring early had a large-amplitude, a steep slope, involved broad regions of the cortex, predominated over fronto-medial regions and preferentially originated from the sensorimotor and the postero-medial parietal cortex. Most slow waves occurring later had a smaller amplitude and slope, involved more circumscribed parts of the cortex and had more evenly distributed origins.

Conclusion: We hypothesize that slow waves in the falling asleep period result from two distinct synchronization processes: 1) a 'bottom-up', sub-cortico-cortical, arousal-system dependent process that predominates in the early phase and leads to 'type I' slow waves, and 2) a 'horizontal', cortico-cortical synchronization process that predominates in the late phase and leads to 'type II' slow waves. The dissociation between these two synchronization processes in time and space suggests that they may be differentially affected by experimental manipulations and sleep disorders.

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0081

ACUTE SLEEP RESTRICTION IN CHILDREN: REGIONAL EFFECTS ON SLEEP EEG BRAIN ACTIVITY

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Introduction: Animal studies show that waking activity as well as sleep is required for the development of certain functions. Throughout childhood, the sleep electroencephalogram (EEG) closely reflects brain maturation, but it is unclear how inadequate sleep is related to brain development. We investigated the effect of acute sleep restriction on sleep EEG topography in children.

Methods: All-night high-density EEG (128 electrodes) was recorded in 8 children (5-12 y, 4m) during habitual sleep (HS) and restricted sleep (RS, i.e. 50% of HS, via delayed bedtime). Standard EEG preprocessing was followed by power and topography calculations. Slow wave (1-4.5 Hz, SWA), theta (4.75-7.75 Hz) and sigma (10-15 Hz) frequencies were analyzed for the first 60 min of slow wave sleep.

Results: RS led to an increase in SWA ($+12 \pm 5\%$, SEM; mean of 109 electrodes; paired t-test $p < 0.05$ for RS/HS), which was most pronounced over two prefrontal (3 and 2 electrodes; $+29 \pm 14\%$ and $+22 \pm 7\%$, respectively; $p < 0.05$) and a parietal cluster of neighbored electrodes (6 electrodes; $+33 \pm 7\%$, $p < 0.005$; repeated measures ANOVA for each electrode with $p < 0.05$). After RS, theta and sigma power neither showed an overall increase nor did clusters of electrodes reveal a significant change in EEG power.

Conclusion: Unlike adults, who exhibit a frontal SWA increase after RS, parietal and prefrontal SWA is enhanced in children. The increased sleep depth in these regions may be related to ongoing maturation of brain morphology and function. Our preliminary results may also suggest that these underlying brain networks are most vulnerable to sleep loss in childhood. Chronic inadequate sleep throughout development may thus have a region-specific effect on brain maturation.

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0082

QUANTITATIVE ELECTROENCEPHALOGRAM MEASURES AS PREDICTORS OF MEMORY IN RATS

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Introduction: Conditions that alter sleep (e.g., sleep apnea syndrome) may adversely affect cognition. We exposed rats to hyperoxia to provoke changes in ventilatory pattern and, by extension, to alter sleep and subsequently determined whether quantitative electroencephalogram (qEEG) measures were associated with Morris water maze (MWM) performance. We compared Zucker Lean (ZL) and Brown Norway (BN) rats considering our previous observation that hyperoxia exacerbated sleep apnea more severely in the latter strain. We hypothesized BN rats to have poorer cognitive performance correlating with qEEG markers.

Methods: N (N = 10) and ZL (N = 11) rats had 3 days to learn platform location in the MWM before they underwent 20-h hyperoxia exposure/polysomnography. Then reversal learning was tested the following day with the MWM platform in a new location. EEG relative power was determined for each sleep frequency band. We computed mean %

power for each band, and a cortical activation ratio ($AR = \alpha + \beta / \delta + \theta$) for each 4-hr increment. We compared strains (t-tests) and determined whether qEEG measures predicted cognitive performance (linear regression). Data are mean \pm SEM.

Results: BN and ZL rats demonstrated comparable learning performance, but in reversal learning ZL rats found the new platform more quickly (32.0 ± 3.4 versus 49.7 ± 4.2 sec, $p = 0.002$). BN rats had higher beta power than ZL rats throughout the first 16 consecutive hrs of the recording. Also, BN rats demonstrated higher cortical activation, which was prominent between hrs 8-12 of the recording ($AR = 2.0 \pm 0.1$ versus 1.7 ± 0.04 , $p = 0.05$). Relative beta power predicted the additional time needed for BN rats to locate the platform.

Conclusion: Our data suggest that qEEG measures (particularly those reflecting the degree of cortical activation) recorded during periods of rest may reflect global cognitive flexibility. Our method for examining sleep and learning in laboratory rats has implications for understanding the neurobiological basis of impaired cognition with sleep apnea syndrome.

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0083

EEG CROSS-FREQUENCY COUPLING DURING WAKEFULNESS IN MILD TRAUMATIC BRAIN INJURY

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Introduction: Mild traumatic brain injury (TBI) causes persistent problems with maintaining wakefulness, but the neurophysiology underlying these symptoms is unclear. EEG cross-frequency coupling (CFC) reflects coordination between neural circuits, an important component of optimal wakefulness. We sought to investigate EEG CFC in a mouse model of mild TBI. We hypothesized that TBI would cause decreased EEG coupling of specific frequency bands important for maintaining wakefulness. Furthermore, we applied a dietary therapy (BCAA: branched chain amino acids) which improves wakefulness and cognition in TBI, and hypothesized that it would restore injury-induced deficits in EEG coupling.

Methods: Mice were randomized to receive mild TBI ($n = 6$), sham surgery ($n = 7$), or TBI plus dietary BCAA therapy (TBI+BCAA: $n = 6$). Each mouse underwent surgical implantation with fronto-parietal EEG and nuchal EMG electrodes for chronic in vivo recording. Amplified polysomnographic EEG/EMG recordings were scored for behavioral state across 5 days of recording (NREM, REM and wakefulness). We analyzed two conditions: (1) Baseline wakefulness from 7:00 pm to 10:00 pm (the period of greatest spontaneous wakefulness in mice) and (2) Exposure to novel environment. Using MATLAB, EEG coupling values were computed from the raw EEG signal by bandpass filtering into delta, theta, alpha, beta and gamma frequencies, followed by Hilbert transformation, then by fast Fourier transformation (FFT) of the signal envelopes. Continuous modulation spectra were binned into 25 coupling combinations: 5 modulation frequency bands and 5 carrier frequency bands. Statistical analyses were performed in R using Kruskal-Wallis analysis of variance.

Results: TBI and sham mice showed statistically significant differences in 12/25 coupling measures, primarily involving the alpha and delta bandwidth combinations ($p < 0.05$). Dietary BCAA therapy restored coupling in TBI mice for 7/25 bandwidth pairs (i.e., alpha-delta,

alpha-theta, alpha-alpha, alpha-beta, alpha-gamma, gamma-delta, and gamma-theta) during baseline wakefulness, and in 5/25 bandwidth pairs (i.e., alpha-beta, theta-delta, theta-alpha, theta-beta and theta-gamma; $p < 0.05$) during the novel environment condition.

Conclusion: EEG CFC is persistently disrupted after mild TBI. Dietary BCAA therapy improves specific EEG CFC measures. Specific changes in alpha or gamma coupling could represent an EEG signature or biomarker of mild TBI, likely reflecting lasting deficits in information processing during wakefulness. Further investigation is warranted into the mechanisms underlying EEG coupling deficits in TBI and whether these can predict functional outcomes.

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0084

SEX DIFFERENCES IN INSULIN SENSITIVITY DURING INSUFFICIENT SLEEP AND ASSOCIATED CIRCADIAN MISALIGNMENT

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Introduction: Experimental studies have indicated that insufficient sleep increases food intake and reduces insulin sensitivity. We previously reported sex differences in the relative amount of *ad-libitum* food intake during insufficient sleep compared to adequate sleep, and furthermore that insufficient sleep may impair insulin sensitivity in part through circadian misalignment. To further explore sex differences, we investigated circadian misalignment and the change in insulin sensitivity during a week of insufficient sleep in males versus females.

Methods: We conducted a cross-over 14-15 day in-laboratory study where 16 healthy adults (8 males/8 females, aged 22.4 ± 4.8 y [mean \pm SD]), completed 3 baseline days (9 h sleep opportunity per night) followed by 5 day control (9 h opportunity per night) and insufficient sleep conditions (5 h sleep opportunity per night), simulating a work-week. Food intake at baseline was designed to meet daily caloric needs, whereas food intake for control and insufficient sleep conditions was *ad-libitum*. Insulin Sensitivity (S_i ; Matsuda Index) was determined by oral glucose tolerance tests and circadian phase was determined using dim-light melatonin offset (DLMOFF).

Results: DLMOFF time was similar in males and females. Baseline S_i was better ($P \leq 0.01$) in males compared to females, and negatively correlated with percent fat mass ($r = -0.77$; $P \leq 0.01$). Greater percent fat mass ($P \leq 0.01$) in females versus males, likely contributed to worse baseline S_i in females. Relative to baseline, insufficient sleep reduced ($P \leq 0.01$) S_i in males, whereas there was a non-significant trend for reduced S_i in females ($P = 0.058$). For males, later DLMOFF time was associated ($r = -0.67$; $P \leq 0.01$) with reduced S_i across conditions.

Conclusion: Circadian misalignment occurs as a result of insufficient sleep in both males and females. Such circadian misalignment, especially for males appears to contribute to worse insulin sensitivity.

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0085

MAGNITUDE OF THE IMPACT OF OBJECTIVELY-RECORDED NOCTURNAL HOT FLASHES ON POLYSOMNOGRAPHIC SLEEP IN PERIMENOPAUSAL WOMEN

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Introduction: The approach of menopause is associated with a dramatic increase in sleep complaints, hypothesized to be due in part to the presence of hot flashes. However, studies attempting to link objectively-recorded hot flashes and sleep quality have produced inconsistent results. We therefore aimed to investigate what proportion of wake time, assessed with polysomnography (PSG), is attributed to the presence of objective nocturnal hot flashes.

Methods: 31 perimenopausal women (age: 50.6 y (SD 2.6)) underwent 1-5 laboratory-based PSG recordings, from which 184 hot flashes were identified, based on a sharp rise in skin conductance. Women had between 1-9 hot flashes per night. The number of minutes of wakefulness immediately following a hot flash was calculated and summed for each night. Impact of objectively identified hot flashes on PSG sleep and the relationship between objective and subjective measures of hot flashes were analyzed with hierarchical mixed-effect models.

Results: Based on PSG, the sample had 84.4% sleep efficiency (95%CI: 82.3-86.6), 58.2 min of wake after sleep onset (95%CI: 48.9-67.5) and 25.5 awakenings (95%CI: 21.8-28.6). Women had 3.4 (95%CI: 2.7-4.1) objective hot flashes per night. There were, on average, 16.7 min (95%CI: 10.5-22.9) of wakefulness due to hot flashes per night, with a high night-to-night variability within women. While subjective and objective measures were positively correlated for numbers of awakenings ($p < .001$), hot flashes ($p = .027$) and wake after sleep onset ($p < .001$), individuals underestimated number of awakenings and overestimated wake after sleep onset and number of hot flashes. Number of objective hot flashes significantly predicted the amount of PSG time awake due to hot flashes per night ($p = .041$) and self-reported severity of hot flashes ($p = .009$). Between-subject variance in number of nights and time in bed was small.

Conclusion: Approximately 30% of the total wake time after sleep onset can be attributed to objectively-recorded hot flashes in these perimenopausal women. The data provide objective validation of hot flashes as a cause of clinically significant sleep disturbance.

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0086

MELATONIN DECREASES BLOOD PRESSURE IN HYPOXIC CONDITIONS ON NORTH AMERICA'S HIGHEST PEAK

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Introduction: Worldwide, 140 million people live above 2,400 m and even more visit high altitudes every year. High altitude exposure is associated with hypoxia-related increases in blood pressure. Increases in blood pressure have been reported to increase the risk for cardiovascular disease in normoxic conditions. Additionally, moderate to high altitudes have been reported to increase the risk for sudden cardiac death. Because melatonin has vasodilatory properties, it may be an effective countermeasure to the hypoxic-related increases in blood pressure. However, melatonin has yet to be tested as a countermeasure to the effects of hypoxia. The aim of this study was to determine if melatonin could decrease blood pressure at high altitude.

Methods: A placebo-controlled, double blind, within-subjects design was conducted on sixteen climbers at 4,300 m (14,200 ft.) on Mt. McKinley. Participants were studied on two consecutive evenings and received melatonin one evening and placebo the other evening (randomized, crossover, counter-balanced). Blood pressure was measured using an automatic blood pressure monitor 10 min prior to (baseline) and 30, 60 and 90 min after study drug administration. Study drug administration was 90 min prior to habitual sleep time.

Results: Repeated measures ANOVA revealed that melatonin decreased systolic blood pressure when compared to baseline and placebo ($p < 0.05$). Diastolic blood pressure was not significantly affected by melatonin.

Conclusion: Despite use in extreme conditions of cold and high altitude (non-laboratory conditions), melatonin decreased systolic blood pressure when compared to placebo and baseline. The decrease in systolic blood pressure may be beneficial in preventing the increase in cardiovascular disease that has been reported with high altitude. Melatonin is a safe, natural, readily available, over-the-counter dietary supplement that could be beneficial to the millions of people that live and visit higher altitudes.

Support (If Any): Faculty Development and Foundation Grants from the College of Arts and Sciences, University of Alaska-Anchorage sponsorship from Mountain Hardwear, Inc.

0087

THE INTERACTION BETWEEN THERMOREGULATORY AND SLEEP REGULATORY SYSTEMS DURING SLEEP CHARACTERIZED BY HEMODYNAMIC MEASUREMENTS WITH NEAR-INFRARED SPECTROSCOPY

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Introduction: Thermoregulatory system (TRS) and sleep regulatory system (SRS) are two independent but interacting systems. Sleep propensity is coupled with TRS but the exact mechanism of how SRS and TRS interact during sleep is less known. As hemodynamic parameters are ideal markers to study this question we measured peripheral (muscle) and cerebral (brain) hemodynamics by near-infrared spectroscopy (NIRS) during the first sleep cycle.

Methods: We assessed HbO₂, HHb, and blood volume (BV) changes in left forehead and biceps using NIRS with combined video-polysomnography in 14 healthy adults during nocturnal sleep. The mean values of hemodynamic parameters during wakefulness, sleep stages 1 (N1), 2 (N2), and slow wave sleep (SWS) were compared (t-test, $p < 0.05$). The inflection points of cerebral hemodynamic changing curves and SWS latencies were studied (Pearson's correlation & t-test, $p < 0.05$).

Results: Compared to wakefulness, a significant decrease in HbO₂ and BV but an increase in HHb is observed in brain after entering N1, while in muscle only BV increases but HbO₂ and HHb show no significant changes. The nadir of cerebral HbO₂ and BV occurs before SWS onset and returns to increase during SWS while HHb begins to decrease. By contrast muscular BV steadily increases from N1 to SWS. The inflection points of cerebral HbO₂ and BV are correlated to the SWS latencies.

Conclusion: The decrement of cerebral BV and increment of muscular BV during N1 and N2 is in line with TRS processes during sleep onset. The nadir of cerebral BV before SWS and subsequent increase of BV during SWS suggests a crucial role of SRS to initiate SWS accompanied with increasing blood supply. The continuous increment of muscular BV also during SWS indicates a predominating TRS in the muscle. The increased HbO₂ and decreased HHb in brain during SWS suggest reduced cerebral oxygen consumption caused by SRS.

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0088

CROWDSOURCING THE IDENTIFICATION OF SLEEP SPINDLES: MAN VS MACHINE

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Introduction: Sleep spindles are brief, distinct bursts of activity in the sigma frequency range (11-16 Hz). They have a characteristic waxing and waning shape and are a key EEG feature used during sleep scoring to define non-REM stage 2 (N2) sleep. Traditionally, spindles are identified by visual inspection of the EEG by trained technologists. There are also numerous automated methods designed to perform this spindle identification task. The purpose of this study is to quantitate the spindle identification performance of experts, non-experts, and automated spindle-detection algorithms.

Methods: EEG data for spindle scoring was from N2 sleep of 110 older aged subjects (57 ± 8 years; mean \pm SD) from the general population. We used an internet interface to facilitate the presentation of EEG data and crowdsource the visual identification of sleep spindles by experts (Registered Polysomnography Technologists), and non-experts who were trained using written instructions. Six previously-published automated spindle detection algorithms were also implemented for testing. We developed a method for establishing the optimal level of group consensus, and refined methods of evaluating the performance of event detectors in 2 dimensional physiological signals such as polysomnography.

Results: In total, 24 experts and 114 non-experts scored sleep spindles in 32,112 epochs of sleep EEG data. Sleep spindles were on average 0.75 ± 0.27 s in duration, oscillated at 13.31 ± 1.04 Hz, were 27.01 ± 11.02 μ V in amplitude and tended to be symmetrical. Compared to this gold standard comprised of the expert group consensus, the highest spindle detection performance was by individual experts (F1-score = 0.75 ± 0.06) and the non-expert group consensus (F1-score = 0.67), followed by automated spindle detectors (F1-score range = 0.21-0.52).

Conclusion: Crowdsourcing is an efficient method to collect large datasets, even for difficult tasks such as sleep spindle identification. Low quality data from individual non-experts can be significantly improved by quality control procedures and using the group consensus. Further refinements to automated sleep spindle detectors are needed.

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0089

HABITUAL NAPPING IS ASSOCIATED WITH INCREASED SLEEP SPINDLE DENSITY AND DECREASED SLOW WAVE ACTIVITY DURING A DAYTIME NAP

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Introduction: Prior studies have shown systematic differences in sleep architecture between habitual and non-habitual nappers during a day-

time nap (McDevitt et al., 2012). People who napped more frequently had lighter Stage 1 & 2 sleep and less slow wave sleep (SWS). Here, we investigated differences in sleep spindle density and EEG power densities during a nap. Based on our prior findings, we hypothesized habitual nappers would show greater spindle densities, indicating lighter sleep, and non-nappers would show greater slow wave activity (SWA), indicating deeper sleep.

Methods: Subjects were categorized as habitual [$N = 12$ (8F), age = 22 ± 2.6 yrs, 1 or more naps/week] or non-habitual [$N = 13$ (9F), age = 24 ± 3.4 yrs, 0 naps/week] nappers based on number of naps taken the week prior to the study. All subjects took a 90 min, polysomnographically-recorded nap between 1:30-3:30 PM. Sleep spindle densities were defined as spindles/minute of non-rapid-eye-movement (non-REM) sleep. We examined power densities during non-REM and REM sleep stages for SWA (5-4 Hz), theta (4-7 Hz), alpha (8-12 Hz), sigma (12-16 Hz), and beta (17-30 Hz). Group differences were determined by independent samples t-tests.

Results: Habitual nappers had higher spindle densities over central, occipital, and parietal sites in non-REM ($p = 0.005$) compared with non-habituals. Additionally, non-habituals had greater SWA in frontal, central, and parietal sites during non-REM ($p = 0.013$). No differences were found in minutes of any sleep stage.

Conclusion: We show that people who nap have increased sleep spindles, while people who avoid napping show increased SWA. These data are consistent with prior findings that habitual nappers have lighter sleep in their naps, whereas non-habituals have more deep sleep. Since greater deep sleep (SWS) has been correlated with increased sleep inertia, people may avoid napping due to this detrimental effect. Our data indicate that SWA may also be a marker for nap preference.

0090

SHORT-TERM RELIABILITY OF HEART RATE VARIABILITY MEASURES IN A DAYTIME NAP

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Introduction: Sleep features and physiological indices vary largely not only between individuals, but also intra-individual. One exception is heart rate variability (HRV), a non-invasive tool to assess autonomic cardiac control which exhibits good short-term intra-individual stability for nighttime sleep (Israel et al., 2012). Here, we investigated the short-term reliability of HRV indices in daytime sleep.

Methods: Seventeen participants (Mage = 23.18 ± 3.03 yrs, 10F) took two 90-minute, polysomnographically recorded naps between 1:30 and 3:30 PM, with two weeks between recordings. Beat-by-beat RR interval values (RR), high frequency (HF) power, low frequency (LF) power and the ratio (LF/HF) of these HRV components were obtained for the whole sleep period. One sample t-tests, standard error of measurement (SEM), interclass correlations (ICC) and Bland-Altman plots with limits of agreement were computed for each parameter.

Results: Participants exhibited high reliability on all HRV parameters. For each index, differences between the recordings was not significantly greater than zero and SEMs lay inside the 95% limits of random variation (i.e. the confidence interval within which 95% of the differences between two measurements are expected to lie due to pure random variability), indicating that the difference between naps was due to pure physiological variability and not to a meaningful change. The ICC values showed good agreement between the two recordings for RR (0.85), HF (0.78), LF (0.76) and LF/HF (0.88), indicating that only 12-24% variance was due to random error. Also, Bland-Altman plots and limits of agreement revealed no systematic change between naps.

Conclusion: HRV parameters during a daytime nap revealed good short-term stability, and indicate that a reliable intra-individual measure of autonomic cardiac health can be obtained by just a single daytime nap. These results have pragmatic implications in both clinical and research fields, suggesting that multiple sleep recordings are not always necessarily required.

0091

EVIDENCE FOR A DAYTIME NAP AS A CARDIOVASCULAR "BREAK"

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Introduction: Heart rate variability (HRV) is used to evaluate autonomic activity during nocturnal sleep. During non-rapid-eye-movement (NREM) sleep, compared to wake and REM, studies report: 1) lengthening of the mean interval between heart beats (R-R interval); 2) an increase in high frequency (HF; 15-40 Hz) but not low frequency (LF; .04-.15) power; and 3) decreased LF/HF ratio. These findings indicate an overall reduction in cardiovascular output during NREM (Busek et al., 2005), which has been associated with significant benefits to the cardiovascular system (Trinder et al., 2011). We investigated if similar autonomic patterns are evident during daytime sleep.

Methods: Each participant [$N = 22$ (5F), Mage = 19.7 ± 1.28 yrs] took a 90-minute, polysomnographically-recorded nap at 1:30 PM with five minutes of waking electrocardiogram recording directly pre-and-post-nap. We measured R-R intervals total power, LF power, and HF power in Stages 2, 3 and REM. Repeated-measures ANOVA with Tukey post-hoc tests compared differences in HRV parameters across sleep stages.

Results: Similar to nocturnal sleep, mean RR intervals were significantly longer in Stages 2 and 3 than wake. RR intervals during REM were longer than pre-nap wake, but not post-nap. HF power was higher in Stages 2 and 3 compared to wake and REM sleep and LF power was lower in Stages 2 and 3 when compared to wake and REM. A significant reduction of the LF/HF ratio in Stages 2 and 3 when compared to wake and REM was also present.

Conclusion: Power spectral analysis of HRV during a daytime nap revealed similar patterns to those found during nocturnal sleep. These findings suggest that daytime naps provide the same cardiovascular 'break' and benefit as nocturnal sleep.

0092

CUMULATIVE TOTAL SLEEP TIME OVER THE PRECEDING FOURTEEN DAY PERIOD SIGNIFICANTLY PREDICTS WAKING FUNCTIONAL CONNECTIVITY OF THE MESIAL PREFRONTAL CORTEX

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Introduction: Integrity of default mode network (DMN) functional connectivity (FC) may be a sensitive marker of prior sleep history, which may help to elucidate the link between sleep and cognition, and explain individual differences in susceptibility to sleep deprivation (SD). We examined whether inter-individual differences in FC strength between major nodes of the DMN during wakefulness was related to individual's cumulative total sleep time (cTST) over the preceding two weeks.

Methods: We acquired waking fMRI data at 3T from fifteen healthy adults (9 female, age 23-59 years). Regions of interest (ROI) representing major nodes of the DMN (mPFC, PCC, IIPC, rIPC, IMTL, rMTL) were created from independent component analysis of a separate cohort of 55 resting subjects (28 male, age 25 ± 4 yrs). Seed-based FC analysis was performed between each pair of ROIs using standard methodology. Multiple regression was performed for each seed-target pair of ROIs to investigate how strength of FC was predicted by four sleep variables: cTST, TST on day 14, age and the Pittsburgh sleep quality index (PSQI). **Results:** Reduced cTST was associated with reduced pairwise FC strength between the mPFC and other DMN ROIs. When seeding FC in the mPFC, cTST significantly predicted FC strength to the PCC ($p = 0.004$), IIPC ($p = 0.023$), and IMTL ($p = 0.017$), with a similar trend for rIPC ($p = 0.066$). Seeding in other ROIs, cTST was a significant predictor when the mPFC was the target (PCC-mPFC $p < 0.001$, IIPC-mPFC $p = 0.014$, rIPC-mPFC $p = 0.048$, IMTL-mPFC $p = 0.012$, rMTL-mPFC $p = 0.041$). TST day 14, age, PSQI were not significant predictors. **Conclusion:** TST over two weeks significantly predicts waking FC between the mPFC and the DMN. As cTST decreases, so does mPFC FC. The mPFC has been implicated in a range of cognitive functions including executive function, attention and memory, and this finding could explain the performance deficits observed with sleep restriction and deprivation.

0093

OREXINERGIC ANTAGONIST SB 334867 IN THE PEDUNCULOPONTINE TEGMENTUM (PPT) ATTENUATES RESPIRATORY RESPONSE TO GLUTAMATE

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Introduction: The orexinergic system provides powerful inputs to sleep/wake regulatory and autonomic control systems. Degeneration of orexinergic neurons underlies human narcolepsy, and orexin knock-out mice exhibit narcolepsy and spontaneous apneas during sleep. It is known that PPT receives significant orexinergic inputs, and our laboratory demonstrated that PPT participates in respiratory control, with stimulation of PPT by glutamate producing apnea and increasing respiratory variability. The aim of the present study was to define the impact of orexinergic neuromodulation in PPT on respiratory control and respiratory responses to glutamate.

Methods: Experiments were conducted on 7 nembutal anesthetized (50 mg/kg) spontaneously breathing rats. Respiration was registered by a piezoelectric strain gauge. Glutamate (10 mM) was injected into the PPT to identify respiratory-related sites. Subsequent injections of vehicle (DMSO), orexinergic OX1 receptor antagonist (SB334867: 10 mM) and glutamate were separated by 10 min intervals. Respiratory timing (TT), tidal volume (V_T) and respiratory timing variability (CVTT) were assessed over 2 min pre- and postinjection intervals. Data were assessed by paired t-test.

Results: Injection of glutamate into respiratory related sites of PPT evoked apnea with a latency 15 ± 10 s post-injection and increased respiratory variability (CVTT: 0.18 ± 0.06 vs 0.048 ± 0.008 pre-injection, $p < 0.05$). Injection of SB334867 into PPT did not change respiratory parameters (CVTT: 0.06 ± 0.005 , $p > 0.05$ vs baseline), but inhibited the response to the subsequent injection of glutamate (CVTT: 0.058 ± 0.004 , $p > 0.05$ vs pre-SB334867).

Conclusion: These findings suggest that orexinergic signaling in PPT plays an important role in respiratory regulation with suppression of OX1 receptors opposing a destabilizing effect of PPT neuronal activation.

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0094

DIVERGENT INNERVATION AND PROPERTIES OF HUMAN GENIOGLOSSAL AND INTRINSIC MUSCLE MOTOR UNITS IN THE TONGUE OF HEALTHY HUMAN SUBJECTS

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Introduction: The longitudinal muscle fibers of the genioglossus (GG) form the bulk of the muscle mass at the base of the tongue and cause an anterior movement of the tongue. Interspersed among GG muscle fibers are the intrinsic (INT) tongue muscles. This study explored the pattern of neural innervation and intramuscular distribution of individual GG and INT motor units by means of single motor unit (SMU) recordings from multiple sites within the tongues of healthy human subjects.

Methods: Lingual muscle EMG was recorded from 25 adult males instrumented with a face mask with pressure and flow transducers and an esophageal pressure transducer who were quietly awake in a supine position. Four monopolar EMG recording wires were placed by subcutaneous approach into the base of the tongue (left-right, anterior-posterior). Sixty nine data segments in which at least one lead contained distinctly large action potentials generated by a SMU were selected for analysis. Such SMU action potentials (92-692 uV amplitude) were used as triggers for forward and backward spike-triggered averaging (STA) of EMG signals at the remaining three recording sites. Spontaneous activity of each triggering SMU was classified as inspiratory (I), expiratory (E), or not respiratory-modulated (T).

Results: Consistent with the longitudinal orientation and large size of GG SMUs, 63% of electrodes ipsilateral to the trigger yielded sharp action potentials with amplitudes larger than 25 uV ($140 \text{ uV} \pm 40$ (SD), $n = 36$) and time leads or lags up to 3.4 ms. The trigger SMUs yielding these averages had E-patterns (35%), I-patterns (21%) or T-patterns (7%). Interestingly, 23% of trials yielded sharp action potentials with > 25 uV amplitudes and leads or lags of up to 5.7 ms from one or both recording sites contralateral to the trigger. These potentials tended to be smaller than those on the same side ($70 \text{ uV} \pm 57$, $n = 17$), and 24% were obtained with I, 41% with E, and 35% with T triggers.

Conclusion: The pattern of STA potentials suggests that most GG SMUs receive uncrossed motor innervation but a few receive crossed innervation. INT motor units, recognized here by strong contralateral and weak or no ipsilateral STAs, have predominantly a T discharge.

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0095

SELF-DISSIMILARITY OF RESPIRATORY EFFORT ACROSS SLEEP STATES AND TIME

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Introduction: Respiratory activity strongly associates with sleep states. For instance, respiration is more regular during deep sleep compared with wakefulness. When awake, the respiratory regularity and the measurement of respiratory effort would be influenced by motion artifacts or other external factors. We therefore tested the hypothesis that the self-dissimilarity of respiratory signal morphology within a subject differs between sleep states, which would in turn help separate them. Moreover, the self-dissimilarity between two periods of respiratory signals might be in accordance with their time difference, which was investigated for each state.

Methods: Continuous overnight respiratory effort signals (acquired with respiratory inductance plethysmography) of 48 healthy adults (age 41.3 ± 16.1 years) were analyzed. Sleep states were scored on 30-s epochs using polysomnography according to R&K rules. For each state, we computed the self-dissimilarity Ds between every two epochs of respiratory effort per subject. Ds was measured by a uniform-scaling distance between the subseries with same number of consecutive breaths (normalized to have zero mean and unit variance) of the corresponding two epochs. A larger Ds value ($Ds \geq 0$) indicates a higher self-dissimilarity.

Results: The self-dissimilarity Ds was significantly different (Mann-Whitney test, $p < 0.001$) between wake (1.0 ± 0.29), REM sleep (0.95 ± 0.27), light sleep (0.83 ± 0.30) and deep sleep (0.70 ± 0.31) regarding respiratory effort. We also found that the longer time between two epochs the higher Ds between them.

Conclusion: Sleep states can be differentiated using respiratory self-dissimilarity expressing the signal morphology which is usually evoked by the autonomic activity, the alternation of ventilation control or other external factors such as will or body movements. The lower self-dissimilarity score in short term implies the inclusion of nonrandom components of respiration which might be explained by less influence of body movements, presence of consciousness or memory of breathing control.

0096

ROLE OF OREXIN IN RESPIRATORY AND SLEEP HOMEOSTASIS DURING UPPER AIRWAY OBSTRUCTION IN RATS

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Introduction: Chronic upper airway obstruction (UAO) elicits a cascade of complex endocrine derangements that affect growth, sleep, and energy metabolism. We hypothesized that elevated hypothalamic orexin has a role in maintaining ventilation during UAO, while at the same time altering sleep-wake activity and energy metabolism. Here, we sought to explore the UAO-induced changes in hypothalamic orexin and their role in sleep-wake balance, respiratory activity and energy metabolism.

Methods: The tracheae of 22-day-old Sprague-Dawley rats were surgically narrowed; UAO and sham-operated control animals were moni-

tored for 7 weeks. We measured food intake, body weight, temperature, locomotion, and sleep/wake activity; magnetic resonance imaging was used to quantify subcutaneous and visceral fat tissue volumes. In week 7 the rats were sacrificed and levels of hypothalamic orexin, serum leptin, and corticosterone were determined. The effect of dual orexin receptor antagonist (almorexant 300 mg/kg) on sleep and respiration was also explored.

Results: UAO increased hypothalamic orexin mRNA and protein content by 64% and 65%, respectively. UAO led to 30% chronic sleep loss, excessive active phase sleepiness, decreased body temperature, increased food intake, reduction of the abdominal and subcutaneous fat tissue volume, and growth retardation. Administration of almorexant normalized sleep but induced severe breathing difficulties in UAO rats while it had no effect on sleep or on breathing of control animals.

Conclusion: In UAO animals, enhanced orexin secretion, while crucially important for respiratory homeostasis maintenance, is also responsible for chronic partial sleep loss, as well as considerable impairment of energy metabolism and growth.

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0097

INFLUENCE OF CHRONIC EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELD OF LOW INTENSITY ON SLEEP

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Introduction: Several studies showed that people living near a base station antenna reported sleep disturbances and discomfort but this remains questionable. These symptoms could be due to a possible effect of radiofrequency electromagnetic field (RF-EMF) on thermoregulatory processes since previous study has shown that chronic exposure to RF-EMF of low intensity induces a fall of skin temperature of the rat's tail without any change of central temperature. The present study was thus undertaken to assess the changes in the thermal preference and in sleep stage distribution in young male Wistar rats.

Methods: 18 animals were divided into an exposed group to RF-EMF during 5 weeks and a control non exposed group. The thermal preference was assessed with an experimental chamber made of 3 interconnected compartments in which air temperature (Ta) was randomly set at 24, 28 and 31°C. Sleep was recorded by a telemetric system and the temperature of the surface of the tail by infrared thermography.

Results: Results pointed out that compared to the animals of the control group exposure to RF-EMF induced an increase of peripheral vascular tone. The animals of the exposed group prefer to sleep at Ta = 31°C whereas the controls prefer 28°C. In this condition, the sleep duration increased significantly (+23.3%) as a result of increases of Slow Wave Sleep (SWS: +18.9%) and of micro wakefulness (microW: +3.2%) as well as SWS and microW frequencies (+6.0 and +5.1 episodes h⁻¹, respectively). The duration and frequency of paradoxical sleep remained unchanged.

Conclusion: It is concluded that change in sleep state distribution can be determined by skin temperature inputs. The modulation of SWS more in terms of episode frequency that duration can be considered as a protective adaptation against RF-EMF exposure that preserves the maintenance of this sleep stage but also occurrence of PS episodes.

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0098

THE ROLE OF INTERLEUKIN-1 IN EPILEPSY-INDUCED SLEEP ALTERATIONS

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Introduction: Interleukin-1 (IL-1) enhances non-rapid eye movement sleep (NREMS) and is associated with many sleep disorders. Previous studies have proved the up-regulation of IL-1 concentrations during epilepsy. In this study, we recorded the sleep patterns of IL-1 type 1 receptor homozygous knockout mice (IL-1 R1 -/-) to evaluate the role of IL-1 in sleep, and investigated the influence of IL-1 on sleep in an animal model of temporal epilepsy.

Methods: Mice were surgically implanted with electroencephalogram (EEG) electrodes to record the sleep-wake activities and to determine the sleep difference between IL-1 R1 -/- mice and wild-type mice. Rapid electrical amygdala kindling (REAK) was performed to induce the dark-onset seizure. Sleep-wake activities before and after REAK were acquired to evaluate the role of IL-1 in epilepsy-induced sleep alterations by comparing the difference between wild-type and IL-1 R1 -/- mice.

Results: The percentage of NREMS ($23.6 \pm 2.6\%$, $n = 6$) obtained from IL-1 R1 -/- mice during the dark period was significantly higher than that obtained from wild-type mice ($16.5 \pm 2.0\%$, $n = 8$). The percentage of rapid eye movement sleep (REMS) ($16.6 \pm 1.3\%$, $n = 6$) obtained from IL-1 R1 -/- mice was significantly lower than that obtained from wild-type mice ($11.3 \pm 1.0\%$, $n = 8$). After the dark-onset kindling, the amount of NREMS increased from $11.7 \pm 2.3\%$ to $20.1 \pm 2.6\%$ ($n = 8$) during first 6-hour dark period in wild-type mice. This result is consistent with our previous study in a rat model. IL-1 R1 -/- mice showed no change in NREMS after the dark-onset kindling during the first 6-hour dark period. The amount of NREMS obtained from IL-1 R1 -/- mice before and after dark-onset kindling were $12.7 \pm 3.0\%$ and $15.5 \pm 3.0\%$ ($n = 6$), respectively.

Conclusion: This result confirms that the sleep enhancement induced by the dark-onset kindling was mediated by IL-1.

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0099

AMYGDALA OPIOID RECEPTORS MEDIATE THE BLOCKADE OF ELECTROACUPUNCTURE ON EPILEPSY-INDUCED SLEEP DISRUPTIONS

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Introduction: Our previous results demonstrated that high frequency (100 Hz) electroacupuncture (EA) stimulation of bilateral Feng-Chi (GB20) acupoints deteriorates epilepsy-induced sleep disruptions. This current study further investigated the effects of low frequency (10 Hz) EA stimulation of Feng-Chi acupoints on epilepsy-induced sleep disruptions and elucidated the role of amygdala opioid receptors in the EA's effect.

Methods: Male Sprague-Dawley (SD) rats, weighted 250-300 g, were used for electroencephalography (EEG) and sleep recordings. Low-frequency (10 Hz) EA stimuli were performed 30 minutes prior to the dark period in three consecutive days. Focal epilepsy was induced by microinjection of pilocarpine into the left central nucleus of amygdala (CeA) in the third experimental day. Co-administration of opioid receptor antagonists into amygdala was used to elucidate the role of opioid receptors in the CeA.

Results: Administration of pilocarpine into CeA induced focal epilepsy and decreased both rapid eye movement (REM) sleep and non-REM (NREM) sleep. NREM and REM sleep respectively decreased from $50.5 \pm 1.9\%$ and $15.3 \pm 1.3\%$, obtained from sham control rats, to $33.8 \pm 3.2\%$ ($p < 0.05$) and $8.9 \pm 1.0\%$ ($p < 0.05$) after administering pilocarpine. The 10 Hz EA stimulation of Feng-Chi acupoints significantly reversed epilepsy-induced decrease of NREM sleep to $45.8 \pm 2.3\%$ ($p < 0.05$ vs. the pilocarpine effect), but had no effect on the REM sleep disruption. The effect of 10 Hz EA stimulation on epilepsy-induced decrease of NREM sleep was blocked by microinjection of μ -receptor antagonist (naloxonazine) into the CeA, but was not affected by naloxone, κ - (*nor*-binaltorphimine) or δ -receptor antagonist (natriindole).

Conclusion: Our study suggests that 10 Hz EA stimulation of bilateral Feng-Chi acupoints exhibited benefit of improving epilepsy-induced sleep disruptions. Our results further demonstrate that μ -opioid receptors in the CeA mediated EA's effect on blocking epilepsy-induced sleep disruption.

0100

IS PARADOXICAL SLEEP A SENSITIVE INDEX OF THERMONEUTRALITY IN RATS?

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Introduction: The thermoneutral zone can be defined as a zone in which the duration of paradoxical sleep (PS) is maximal since there is a strong functional interaction between this sleep stage and thermoregulation. Another approach is to assume that preferred air temperature (thermopreferendum) is the thermoneutral temperature in which the animals spend most of its time when allowed free choice. The present study was assessed to compare the sleep stage distribution in animals slept at thermopreferendum and in animals constrained to sleep at imposed air temperatures (Ta).

Methods: Sleep was recorded in a group ($n = 11$) at Ta of 24 or 31°C and in a group ($n = 9$) in which the animals were allowed to move freely between 2 adjacent rooms which differed in air temperatures (24 and 31°C). Slow Wave Sleep (SWS) and PS were scored. The effects of Ta on sleep parameters were compared with the Wilcoxon test.

Results: Results show that the constrained animals slept more at Ta of 31°C than at 24°C. The total durations of SWS and PS increased (+4.5% and +2.3%, respectively) as well as the frequency of SWS episodes (+2.1 episodes h⁻¹) and the mean duration of PS episodes (+42 sec). There was no significant difference of sleep parameters when animals were allowed to choose between 24°C and 31°C.

Conclusion: The present study shows that the duration of paradoxical sleep seems to be a sensitive index to determine thermoneutral zone in animals constrained to sleep at imposed Ta but not when the animals can choose their preferred Ta since paradoxical sleep was not sensitive to Ta. It can be concluded that paradoxical sleep could only define thermoneutrality under specific experimental conditions.

Support (If Any): Grenelle Environnement, Environment Minister of France.

0101

ENDOGENOUS OPIATES IN THE PARABRACHIAL NUCLEUS MEDIATE THE ELECTROACUPUNCTURE-INDUCE SLEEP ACTIVITIES IN RATS

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Introduction: Previous studies indicate that electroacupuncture (EA) of Anmian acupoint (EX 17) enhances vagal activity and changes the synaptic morphology in the nucleus tractus solitarius (NTS) by different EA stimulus frequencies. The goal of this study is to investigate the role of parabrachial nucleus (PBN), which receives afferents from NTS, in the EA-induced sleep alterations.

Methods: Total of six male Sprague-Dawley rats, weighted 250-300 g, was used. We microinjected opioid receptor antagonists: naloxone (broad-spectrum opioid receptor antagonist), naloxonazine (μ -opioid receptor antagonist), naltrindole (δ -opioid receptor antagonist), nor-binaltorphimine (κ -opioid receptor antagonist), into the PBN before the EA stimulation. A 30-minute EA stimulation was performed at the beginning of the dark period in a 12:12 h light:dark cycle. The frequency of EA used in this experiment was 10 Hz, and the EEGs were recorded after EA stimulation and lasted for 24 hours. One-way ANOVA was used for statistical analysis.

Results: Our preliminary results indicated that EA significantly enhanced non-rapid eye movement (NREM) sleep after the 30-minute EA stimuli. Microinjection of naloxone, naloxonazine, naltrindole or nor-binaltorphimine, into the PBN 30 minutes prior to the EA stimulation reduced the EA-induced enhancement of NREM sleep significantly in different time blocks, which original induced by EA.

Conclusion: Our results indicated that 10 Hz EA stimulation of Anmian acupoints increased spontaneous NREM sleep during the dark period, suggesting the sleep improvement for EA stimuli of Anmian acupoints. Microinjection of four opioid receptor antagonists directly into the PBN blocked EA-induced enhancement of NREM sleep, indicating the role of endogenous opioids in the PBN.

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0102

EXPERIMENTALLY INDUCED RHYTHMIC JAW MOVEMENTS DURING NREM SLEEP IN ANIMALS

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Introduction: Rhythmic jaw movements (RJMs) are often observed during NREM sleep in patients with sleep bruxism. Rhythmic component of jaw movements are known to be generated by central pattern generator (CPG) and CPG can be activated by electrical microstimulation to corticobulbar tract in anesthetized animals. This study aimed to investigate the responsiveness of CPG for RJMs to electrical microstimulations during NREM sleep.

Methods: Ten male Hartley guinea pigs were used for the experiments. Animals were equipped with the electrodes for electroencephalographic (EEG), electro-oculographic, electromyographic (EMG) (for dorsal neck, masseter and digastric muscles) and electrocardiographic elec-

trodes for chronic sleep recordings under pentobarbital anesthesia. A stimulating electrode was implanted into the corticobulbar tract where electrical microstimulation (stimulus duration: 2-4 sec; pulse frequency: 30 Hz; current intensity: 0.03-0.1 mA) induced RJMs. Recording sessions with micro-stimulations were done in the freely moving condition. Response rate of RJMs to stimuli was scored and counted during wakefulness and NREM sleep. Time course changes of delta EEG power and mean RR intervals before and after stimulation were analyzed.

Results: Electrical micro-stimulations to corticobulbar tract induced RJMs in the freely moving animals during wakefulness and NREM sleep. RJMs were characterized by rhythmic digastric EMG activity and more than half of them were associated with a concomitant rhythmic masseter contractions. The response rate of RJMs to stimuli was significantly lower during NREM sleep than during wakefulness although it was increased linearly with stimulus intensity in both behavioral states. Induced RJMs during NREM sleep were associated with a significant and transient decrease in delta EEG power and RR intervals.

Conclusion: CPG responsible for RJMs is responsive to corticobulbar tract stimulation during NREM sleep in association with transient arousal phenomena in experimental animals.

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0103

EFFECTS OF 5 DAYS INGESTION OF CHLOROGENIC ACIDS ON SLEEP AND ENERGY METABOLISM

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Introduction: Chlorogenic acids are the most abundant polyphenols in coffee. Recent reports have shown that continuous consumption of chlorogenic acids reduces body fat and body weight. Since control of energy metabolism and sleep share common regulatory factors such as leptin and insulin, consumption of chlorogenic acids might also modulate sleep. However, no studies have evaluated the effect of chlorogenic acids consumption on sleep, and lack of sleep has recently be pointed as a risk factor of metabolic diseases such as hypertension and diabetes. The aim of this study was to determine effects of 5 days ingestion of chlorogenic acids on energy metabolism and quality of sleep in humans.

Methods: Nine healthy male and female subjects, with mean age of 25.7 ± 3.4 yrs and body mass index of 21.8 ± 1.4 kg/m², participated in a placebo-controlled, double-blind, crossover intervention study. The subjects consumed test beverage containing 0 or 600 mg of chlorogenic acids for 5 days. On the night of 5th day, subjects stayed in a whole room metabolic chamber to measure energy metabolism, and polysomnographic recording were performed.

Results: Chlorogenic acids shorten sleep latency compared with control, while no effects on sleep architecture such as SWS, REM and wake after sleep onset were observed. Indirect calorimetry revealed that chlorogenic acids consumption increased fat oxidation but did not affect energy expenditure during sleep. Consumption of chlorogenic acids enhanced parasympathetic activity assessed from variability of heart rate, while increased sympathetic activity the first 2 h of next morning.

Conclusion: Five days consumption of chlorogenic acids significantly increased fat oxidation during sleep, suggesting beverage containing this substance may be beneficial to reduce body fat and to prevent obesity. Consumption of chlorogenic acids shortened sleep latency and caused no adverse effect on sleep.

0104

PEPTIDE YY FOLLOWS THE SLEEP AND WAKEFULNESS RHYTHM IN A SIMULATED SHIFTWORK PROTOCOL

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Introduction: Peptide YY (PYY) is an appetitive hormone produced by the small and large intestines which promotes satiety following consumption of a meal. Administration of PYY is reported to reduce subsequent food intake. Whether PYY is modulated more by wakefulness-sleep or circadian mechanisms is unknown and was therefore examined in the current study.

Methods: Eight healthy adults (5 females) aged (27.3 ± 4.9 y), BMI (22.1 ± 1.8) participated. After one-week of maintaining an ~8 h sleep schedule at their habitual time, participants were studied in a 5 day inpatient simulated nightshift protocol. Night 1 consisted of a sleep disorders screen. Days 2-5 consisted of a constant posture protocol (bedrest, head at 35°) in dim light (< 8 lux max). Day 2 served as baseline with 16 h wakefulness and 8 h sleep opportunity, day 3 was a transition day with an afternoon 2 h nap followed by the first night shift. Days 4 and 5 were the second and third nightshifts with 8 h daytime sleep opportunities. Meals were given at ~1.5 h, 5.5 h, 10.5 h and 14.5 h after wakefulness each day. Blood was sampled every 2 h for PYY. Data were analyzed using mixed model ANOVA and compared using planned comparisons.

Results: At baseline, PYY levels showed a significant daily pattern with high levels during wakefulness and low levels during sleep ($p < 0.05$). During simulated night work with daytime sleep, PYY levels were also high during wakefulness and low during sleep ($p < 0.05$).

Conclusion: These preliminary findings suggest that the gut hormone PYY predominantly shows a daily pattern following the wakefulness-sleep cycle rather than a robust circadian rhythm. The mechanisms underlying this wakefulness-sleep daily pattern (e.g., feeding-fasting, sleep induced decrease) remain to be elucidated.

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0105

SLOW WAVE SLEEP IS LOWER IN HEAVY DRINKING COLLEGE STUDENTS

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Introduction: Alcohol dependence is associated with marked reductions in SWS, which is also predictive of relapse in abstinent alcohol dependent individuals. It has been speculated that reductions in SWS are attributable to reduced neuronal connectivity due to long term alcohol abuse. It is unclear at what point in the aetiology of alcohol use disorders that these sleep changes occur. Heavy and in particular binge drinking is common in college age populations. The current study assessed the effects of drinking history on sleep in this population, comparing heavy versus light drinking patterns, allowing assessment independent of age-related sleep changes or extended chronic drinking histories.

Methods: Laboratory PSG was conducted in 10 heavy drinking (HD: 19.60 ± 1.1 yrs; 125.92 ± 88.19 drinks in the previous month) and 9 light

drinking (LD: 19.78 ± 1.2 yrs; 13.14 ± 8.52 drinks) college age students. Data were evaluated across the first four sleep cycles.

Results: By design, groups differed on drinking history in the previous month ($p = .003$), but did not differ in age, BMI or age at which they started drinking ($p > .05$). No differences were observed between groups for sleep onset latency, time in bed or total sleep time ($p > .05$). HD showed less SWS than LD ($27.06 \pm 6.6\%$ vs. $39.05 \pm 6.6\%$) over all sleep cycles ($p < .001$). HD showed more REM sleep than LD ($21.52 \pm 2.9\%$ vs. $18.37 \pm 2.9\%$) across sleep cycles ($p = .032$). Both groups exhibited the usual sleep cycle related reductions in SWS ($p = .001$) and increases in REM sleep ($p = .001$). No interactions were observed ($p > .05$).

Conclusion: Results suggest that despite a relatively short drinking history, HD young adults show a similar pattern of SWS deficits to those seen in long-term alcohol dependent individuals. It is unclear if these SWS differences precede heavy alcohol use in this group, or if SWS changes are a result of neurophysiological changes associated with relatively short drinking histories.

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0106

ASSOCIATION OF LOW EVENING INDOOR TEMPERATURE WITH PROLONGED SLEEP ONSET LATENCY: BASELINE ANALYSIS OF THE HEIJO-KYO COHORT STUDY

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Introduction: Previous studies about thermoregulation and sleep at controlled settings showed that warm skin temperature in distal region (foot and hand) before bedtime is associated with shorter sleep onset latency. However, the impact of the temperature on sleep onset in real life situation remained unknown. Purpose of this study is to assess the relationship between the indoor temperatures (Temp_{in}) in the evening (2 h before bed time) with the sleep onset latency (SOL) among the elderly.

Methods: Habitual subjective SOL was determined using self-administered questionnaires from The Pittsburgh Sleep Quality Index. Actigraphic SOL and Temp_{in} were simultaneously measured for two consecutive days in colder seasons (October to April) from 2010 to 2013 among 861 elderly participants (mean age \pm SD: 72.1 ± 7.1 years).

Results: Medians (interquartile range) of the habitual subjective SOL and actigraphic SOL, were 15.0 (10.0, 30.0) min and 16.0 (6.0, 34.8) min, respectively. The evening Temp_{in} and initial night-time bed temperature were $17.1 \pm 4.1^\circ\text{C}$ (mean \pm SD) and $29.0 \pm 3.7^\circ\text{C}$, respectively. Evening Temp_{in} revealed a significant inverse association with the log-transformed habitual-subjective SOL in a multivariate linear regression model after simultaneously adjusting for age, gender, drinking habits, insomnia medication, and bedtime ($\beta = -0.014$, $P = 0.049$). A multivariate mixed linear regression model revealed a significant longitudinal association of the lower evening Temp_{in} with the log-transformed actigraphic SOL independent of age, male gender, habitual drinking, insomnia medication, bedtime, and the initial night-time bed temperature ($\beta = -0.017$, $P = 0.03$). According to this model, decrease of Temp_{in} from 25 to 10°C is associated with prolonged sleep onset from 12.2 to 16.2 min.

Conclusion: Findings of the present study may be useful for prevention of insomnia by controlling evening indoor temperature.

0107

THE EFFECT OF A SPLIT SLEEP SCHEDULES (6H-ON/6H-OFF) ON NEUROBEHAVIOURAL PERFORMANCE AND SLEEPINESS

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Introduction: This study examined neurobehavioural performance and sleepiness during two split-sleep schedules with equivalent sleep opportunities per 24 h.

Methods: Sixteen healthy adults (6 males, 26.13 ± 4.46) participated in a 9-day laboratory study that included two baseline nights (BL, 10-h time in bed (TIB), 2200-0800 h), 4 days on one of two types of 6 h on/6 h off split sleep schedules with 5 h TIB during each 'off' period (6 h early: TIB 0300-0800 h and 1500-2000 h, or 6 h late: TIB 0900-1400 h and 2100-0200 h), and two recovery nights (10 h TIB per day, 2200-0800 h). Subjects received 10 h TIB per 24 h in total, across both shift schedules. Participants completed a neurobehavioural test bout every two hours during wake, which included the Psychomotor Vigilance Task (PVT) and the Karolinska Sleepiness Scale (KSS). Linear mixed effects models were used to assess the effect of day (BL, shift days 1-4), schedule (6 h early, 6 h late) and trial (1-6 per day) on PVT lapses (# RTs > 500 ms) and KSS.

Results: There was no significant main effect of day ($p = 0.98$) or schedule ($p = 0.93$) on PVT lapses, nor was there a significant day*schedule interaction ($p = 0.82$) or a significant day*trial interaction ($p = 0.24$); However there was a significant schedule*trial interaction ($p < .001$), with more lapses occurring at 0730 h in the 6 h late schedule. There was a significant main effect of day on KSS ($p < .001$) and a significant day*schedule interaction ($p = 0.03$). While participants reported more sleepiness on shift days than baseline, KSS was greater during the 6 h late schedule. There was no significant day*trial interaction ($p = 0.12$) and no main effect of schedule ($p = 0.29$), however, there was a significant schedule*trial interaction ($p = 0.001$).

Conclusion: These results show that while there was not a cumulative cost across days of splitting sleep, participants reported greater sleepiness during shift days. Tests near the circadian nadir showed higher sleepiness and increased performance deficits.

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0108

CIRCADIAN PHASE AND SLEEP TIMING DIFFER BETWEEN NAPPING AND NON-NAPPING TODDLERS

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Introduction: Individual differences in circadian phase are in part influenced by sleep timing, which "gates" light exposure. The sleep patterns of many toddlers include a daytime nap. This study examines differences in circadian phase and sleep timing in napping and non-napping healthy toddlers.

Methods: Data were collected from 20 children ages 30-36 months (12 females). For 5 days, children slept on their habitual schedules, which were determined by their parents and free to vary. Sleep was continuously monitored with parental diaries and actigraphy. On day 6 of the

protocol, children participated in an in-home salivary dim-light melatonin onset (DLMO) assessment (< 10 lux), during which time they provided saliva samples every 30 min for 6 h. DLMO was the time of the rise in melatonin levels above 4 pg/mL. Independent t-tests were used to compare actigraphic estimates of sleep and circadian measures between children napping at least once ($n = 15$) and those not napping at all ($n = 5$) during the 5-days before the DLMO assessment.

Results: During the 5 days before DLMO, napping children fell asleep during their daytime sleep opportunities 3.6 ± 0.8 days (range = 1-5 days). Compared to non-napping children, those who napped had 38 min later DLMOs ($p = 0.04$; $d = 0.93$), 19 min later bedtimes ($p = 0.01$; $d = 1.25$), 59 min later sleep start times ($p = 0.005$; $d = 1.47$), and 16 min longer sleep onset latencies ($p = 0.03$; $d = 1.04$). Sleep end times did not differ by napping status. Napping children also spent 49 min less time in bed ($p = 0.02$; $d = 1.08$) and had 69 min shorter sleep durations than those not napping ($p = 0.006$; $d = 1.47$). Percent days napping was positively correlated with DLMO phase ($r = 0.50$; $p = 0.01$).

Conclusion: Our findings indicate that daytime napping is associated with later circadian phases, bedtimes and sleep start times and shorter nighttime sleep durations in toddlers. As predicted by the two-process model, napping children likely dissipate sleep pressure during the day, promoting a later sleep onset time, and perhaps a wider phase angle between DLMO and sleep onset. Future studies should examine whether DLMO differences in napping and non-napping children are influenced by the timing and intensity of light exposure.

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0109

SLEEP BEHAVIOR, CIRCADIAN PHASE, AND PHASE ANGLE OF ENTRAINMENT ACROSS ADOLESCENCE: A LONGITUDINAL STUDY

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Introduction: This longitudinal study examined developmental trajectories of sleep behavior, circadian phase, and the interaction between sleep and circadian timing in two adolescent cohorts.

Methods: Ninety-four healthy adolescents participated; 38 (21 boys) were 9-10 years ("younger cohort") and 56 (30 boys) were 15-16 years ("older cohort") at baseline. Follow-up assessments occurred approximately every 6 months for 2.5 years; number of assessments averaged 4.29 (range: 1-6). At each assessment, salivary melatonin was collected in dim light at 30-minute intervals in the laboratory (to compute the dim light melatonin onset (DLMO)) after a week of self-selected school-year sleep. Sleep onset, sleep offset (weekday and weekend), and weekend delay (weekend minus weekday) were derived from wrist actigraphy. Phase angles were the time duration from DLMO to weekday sleep onset and offset times. Mixed models tested for differences across age within each cohort.

Results: Each cohort showed developmentally later sleep onset (weekend and weekday), later weekend sleep offset, and later DLMO. Weekday sleep offset became earlier with age in the younger cohort and was later in the older cohort at age 18. Weekend sleep offset delay became greater

in the younger cohort; however, it decreased in the older cohort at age 18. DLMO phase angle to sleep offset narrowed with age in the younger cohort, and became broader in the older cohort. The older cohort had a wider phase angle to sleep onset (mean = 2.1 h, SD = 0.9 h) compared to the younger cohort (mean = 1.2 h, SD = 0.9 h); however, a developmental increase of phase angle emerged in the younger cohort only.

Conclusion: Across adolescence, circadian phase and self-selected sleep became later, though school-day sleep offset advanced until after high school when offset became later. Sleep behavior may drive circadian timing delays or vice-versa. Phase angle changes likely emerged as developing sleep regulation interacted with adolescent psychosocial factors (e.g., school-start time, bedtime autonomy).

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0110

LATE CHRONOTYPE IS ASSOCIATED WITH INCREASED BODY MASS INDEX AND POORER DIETARY BEHAVIORS

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Introduction: Levels of pediatric obesity continue to rise. Previous evidence has linked short sleep duration to obesity development, but objective data is limited in adolescents. As adolescents transition through puberty, circadian shifts occur, resulting in sleep loss. However, little is known whether chronotype is associated with body mass index (BMI) or dietary behaviors in adolescents. We hypothesized late chronotype would be positively associated with BMI and poorer dietary behaviors.

Methods: A total of 511 UK adolescents (11-13 years) from eight secondary schools across the Midlands region of the UK participated in a cross-sectional study to assess potential relationships between chronotype and BMI z-score as well as dietary habits. Height (cm) and weight (kg) were objectively measured for BMI calculation and participants completed a questionnaire to assess dietary habits. A sub-sample of 236 adolescents wore wrist actigraphy for 7 days to estimate sleep/wake time and average sleep duration (weekday, weekend and combined).

Results: Definitely evening chronotype adolescents had a 0.45 increase in BMI z-score compared to definitely morning chronotypes ($p < 0.05$), after adjustment. Higher frequency of consuming unhealthy snacks, night-time caffeine consumption and inadequate daily intake of fruit/vegetables were also associated with later chronotype (all $p \leq 0.01$). Actigraphy estimated sleep duration was an independent predictor of BMI z-score $\beta = -0.36$, $p < 0.001$.

Conclusion: Later chronotype adolescents are at risk of increased BMI and poorer dietary behaviors. Short sleep duration is also an independent risk factor for increased BMI. Sleep hygiene education may help adolescents to better understand the impact of sleeping habits on physical health.

Support (If Any): This study was provided funding support from the children's charity Action Medical Research.

0111

DELAYED SLEEP TIMING IS ASSOCIATED WITH LOW LEVELS OF FREE-LIVING PHYSICAL ACTIVITY

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Introduction: Short sleep is associated with weight gain, and sleep timing/quality may influence energy balance. We aimed to determine if sleep timing and/or quality are related to physical activity (PA) levels under free-living conditions.

Methods: Data were from 23 participants ($n = 6$ females), age (\pm SD) 35.5 ± 4.7 y and body mass index 23.8 ± 1.1 kg/m². Participants were screened for sleep disorders and habitual sleep of 7-9 h/night. Habitual

total sleep time (TST), sleep efficiency, and PA (metabolic equivalents [METs]) were established over a 2-wk period while free-living, using sleep diaries and waist-actigraphy (Actiwatch, Actilife). Participants also completed the Epworth Sleepiness Scale, Pittsburgh Sleep Quality Index, and Horne-Ostberg Morningness-Eveningness Questionnaire. Quantification of PA included MET rate and % time spent in sedentary, light, moderate, and vigorous/very vigorous PA.

Results: Mean TST was 446.4 ± 32.3 min. Mean bedtime and wake-time were 00:14 (range: 22:02-02:07) and 08:22 (range: 06:30-10:11). Controlling for TST, negative associations were seen for bedtime ($r = -0.445$, $p = 0.038$) and wake-time ($r = -0.495$, $p = 0.019$) with MET rate, for bedtime ($r = -0.470$, $p = 0.027$) and wake-time ($r = -0.519$, $p = 0.013$) with % time spent in moderate activity, and for bedtime ($r = -0.437$; $p = 0.042$) and wake-time ($r = -0.492$; $p = 0.020$) with % time spent in vigorous/very vigorous activity. Late bed/wake times were related to lower PA. Positive relationships were seen between bedtime ($r = 0.416$, $p = 0.054$) and wake-time ($r = 0.470$, $p = 0.027$) with % time spent in sedentary activity, showing increased sedentariness with later bed/wake times. No other significant relationships were observed between sleep measures and PA.

Conclusion: We observed that within normal sleepers, slightly delayed sleep timing is associated with lower PA, suggesting that even within non-pathologically poor/short sleepers, relatively small alterations in sleep timing may influence PA. It is unknown if sleep timing is related to energy intake or balance.

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0112

SEX DIFFERENCES IN THE CIRCADIAN VARIATION OF SLEEP IN HUMANS

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Introduction: Prior studies have demonstrated a shorter circadian period and earlier circadian melatonin and core body temperature (CBT) rhythms in women compared to men. As sleep is influenced by an interaction between sleep/wake and circadian processes, we hypothesized that the circadian variation of sleep is affected by sex.

Methods: Sixteen healthy men (mean age \pm SD: 24.1 ± 4.6 y.o.) and 11 healthy women in their mid-follicular phase (25.8 ± 3.8 y.o.) entered the time isolation laboratory for an 8-h sleep period followed by a 72-h ultradian sleep-wake (USW) cycle procedure. During the USW, participants alternated between 60-min wake episodes (< 10 lux) and 60-min nap episodes (< 0.03 lux). Throughout the USW procedure, subjects maintained a semi-recumbent posture, and were served iso-caloric snacks (1x/2 hrs). Circadian phase was determined based on the CBT nadir (set at 0°). Polysomnographic sleep was recorded during all sleep and nap episodes. The circadian variation of sleep parameters was compared between sexes using non-linear mixed models.

Results: During the baseline nocturnal sleep period, a sex difference was observed only for stage 1 sleep (mean \pm SEM; women: $2.8 \pm 0.4\%$ vs. men: $7.7 \pm 0.9\%$, $p < 0.001$). Throughout the USW, women had overall increased non rapid-eye movement (non-REM) sleep ($p = 0.048$), stage 2 sleep ($p = 0.03$), and reduced stage 1 ($p = 0.04$) and REM sleep onset latency ($p = 0.008$) compared to men. An earlier acrophase of the circadian rhythms of sleep efficiency ($+0:58$, $p = 0.008$), total sleep time ($+0:57$; $p = 0.01$), and slow wave sleep ($+1:38$; $p < 0.001$) was observed in women compared to men.

Conclusion: Our results demonstrate a sex difference in the circadian variation of sleep. These results indicate that women sleep better at earlier circadian phases than men. This observation and the advanced CBT rhythm in women could contribute to sex differences in vulnerability to sleep disturbances.

Support (If Any): This work was supported by CIHR operating grants.

0113

WITHDRAWN

0114

EVENING BLUE-ENRICHED LIGHT EXPOSURE INCREASES HUNGER AND ALTERS METABOLISM IN NORMAL WEIGHT ADULTS

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Introduction: Animal and human models indicate that altering the timing of light-dark exposure influences appetite and weight regulation. The aim of this study was to determine the acute effects of 3 hrs of evening blue-enriched light exposure on hunger, metabolic hormones, and sleepiness.

Methods: Ten healthy adults (6 females; mean age 29.9 ± 6.1 years; mean body mass index 23.8 ± 3.2 kg/m²) with regular sleep and eating schedules completed a 4-day protocol under dim light < 20 lux during 16 hrs of wake and < 3 lux during 8 hrs of sleep. Participants received identical carbohydrate-rich isocaloric meals 1, 5 and 11 hrs after wake and were exposed to 3 hrs of 120 lux blue-enriched light starting 10.5 hrs after wake (Day 3) compared to dim light (Day 2). Visual Analogue Scales for hunger and Karolinska Sleepiness Scales were given hourly 9.75-14.75 hrs after wake. Glucose and insulin were measured from blood drawn 10.5-14.5 hrs after wake at 30 min intervals, and area under the curve (AUC) was calculated 11-14.5 hrs after wake. Homeostatic model assessment of insulin resistance (HOMA-IR) was calculated as fasting glucose (mg/dl) \times fasting insulin (μ U/mL)/405. Differences between blue-enriched light and dim light conditions were analyzed with paired t-tests.

Results: Blue-enriched light resulted in an increase in hunger 15 min after light onset ($p = 0.01$) that was still present 1.75 hrs post meal ($p < 0.001$), larger AUC for insulin ($p = 0.02$), higher peak value of glucose ($p = 0.02$), higher HOMA-IR ($p = 0.002$), and decreased levels of sleepiness during the entire exposure period (all $p < 0.05$) compared to dim light.

Conclusion: Blue-enriched light exposure immediately before and during the evening meal acutely increases hunger, alters glucose metabolism, and decreases sleepiness relative to dim light. More research is needed to determine long-term effects and mechanisms of action. Manipulating environmental light exposure in humans may represent a novel method of regulating food intake patterns for weight management.

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0115

SUB-CORTICAL TEMPORAL INTEGRATION OF ULTRA-SHORT FLASHES OF LIGHT

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Introduction: Beyond image-forming (IF) effects, light detected by a network of retinal rods, cones and intrinsically photosensitive ganglion cells, evoke changes in sub-cortical functions including circadian timing and sleep drive. The physiology of non-image forming (NIF) photoreception remains incompletely understood as it has specific intensity and

timing responses that are distinct from IF. We have shown recently that a sequence of 60 ultra-short (2 ms) flashes administered over 60 minutes can elicit a 45-minute circadian phase delay. Herein, we compare the NIF impact of ultra-short flashes to that of continuous light and present a possible model of NIF temporal integration of light flashes.

Methods: Twenty-six (26 ± 5.2 y.o) healthy adults were empanelled in a 16-day protocol. Participants were exposed on the night of Day 15 to 60 minutes of either continuous bright light ($n = 6$) or ultra-short flashes ($n = 20$) of varying frequency (inter-stimulus intervals, ISI = 2.5 to 240 seconds). Circadian phase shift was calculated as the difference in salivary dim light melatonin onset between Day 15 and Day 16. Alertness and sleepiness levels were monitored Days 15-16.

Results: Light-evoked changes in circadian timing dropped as ISI increased, following a non-linear 2-parameter exponential decay function. A maximum change in circadian timing was observed after a 5-second ISI. This change was larger than the phase shift elicited by continuous light (~43 minutes). Alertness levels were significantly increased under continuous light but not under flashes.

Conclusion: The circadian system appears to integrate ultra-short flashes of light over time in a non-linear fashion. This temporal integration is such that 0.36 seconds of light delivered as discreet flashes evenly distributed over an hour, is equipotent to an equiluminous continuous light exposure 10000 times the duration. Moreover, flashes did not increase alertness and could be considered as an optimal treatment for chronobiological disorders during the nighttime when the circadian system is most sensitive to light.

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0116

NOCTURNAL SLEEP TIMING PREDICTS BOTH TYPE AND TIMING OF FOOD INTAKE BY GIFTED ADOLESCENTS

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Introduction: A late sleep phase (evening active) is related to unhealthier dietary habits relative to an earlier sleep phase (morning active). Adolescence is associated with a sleep phase delay and the risk of adolescent overweight and obesity is a social concern. Gifted students may be especially at risk because of high academic and social demands contributing to bedtime delays. The present study assessed whether the sleep phase of gifted students is related to timing and type of food intake at each hour of the day.

Methods: Data were collected in 2013 from 10- to 15-year olds ($n = 114$; 63% female; 59% Caucasian) attending a three-week summer gifted-student program. A sleep and diet questionnaire included a recall report of likelihood of intake (no to very high) for each hour of the day of 9 food categories (fatty, sugary, and salty, carbs, vegetables, proteins, fruits, and caffeinated and sugary beverages). Students were binned into four sleep-phase groups, Early Early (EE, $n = 19$), Early (E, $n = 47$), Late (L, $n = 29$), and Late Late (LL, $n = 19$) using the mean and SD of the adjusted (for recovery sleep) midpoint of the weekend sleep period.

Results: Group by Block (night, morning, afternoon, evening) comparisons were followed by within-block hourly comparisons as appropriate. No or small group differences were found for vegetables, fruits, or proteins at any hour of the day. Large group differences were found for other food types, especially after the evening meal. For example, less than 20% of the EE group vs. up to 70% of the LL group was likely to consume fatty, sugary, and salty foods during some evening and early night hours.

Conclusion: Early sleep phase predicts the type and timing of food intake considered ideal by nutritionist. Late timing is associated with de-regated eating habits from afternoon to early night hours.

0117

PHYSIOLOGICAL FEEDING SCHEDULE RESTORED 24-HOUR ACTIVITY RHYTHM BUT NOT FRACTAL ACTIVITY IN ANIMALS WITHOUT THE SUPRACHIASMATIC NUCLEI

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Introduction: Motor activity possesses a multiscale regulation as characterized by robust fractal fluctuations with similar temporal structure at different time scales. The multiscale regulation is disrupted in animals after the lesion of the suprachiasmatic nucleus (SCN) and in humans with disrupted SCN function (e.g., aging and dementia) that are all accompanied by reduced/abolished 24-h activity rhythm. In addition to light-dark cycles and the SCN, food availability can provide a time cue and introduce a circadian/daily rhythm in motor activity via metabolic pathways that engage neural networks involved in food digestion and anticipation. Here we tested whether restoring 24-hour activity rhythm by a daily feeding pattern with 12 hours food availability can recover the multiscale activity regulation in SCN-lesioned animals.

Methods: Locomotor activity recordings of 5 intact and 5 SCN-lesioned rats were studied. All animals underwent > 24 days of 12 h:12 h light-dark cycles in which food was available only during the dark phase. Fourier analysis was used to assess 24-h rhythms and detrended fluctuation analysis (DFA) was used to quantify fractal correlations in activity fluctuations at time scales from 0.2-20 hours.

Results: Both intact and SCN-lesioned rats showed significant 24-h rhythms with higher activity levels during the dark phase when food is available. As previously reported, intact rats displayed robust fractal activity fluctuations with strong correlations as indicated by a DFA-derived exponent α close to 0.9 (mean \pm SE: 0.93 ± 0.02). SCN-lesioned rats had disrupted fractal patterns with random fluctuations at time scales > 4 hours as indicated by $\alpha \sim 0.5$ (0.52 ± 0.06 ; $p = 0.0001$), which are identical to activity patterns in the SCN-lesioned animals with ad libitum access to food.

Conclusion: Light-dark cycles and 24-h rhythm of food availability can restore/improve circadian/daily rhythms in SCN-lesioned animals but not necessarily improve the disrupted multiscale activity regulation in these animals.

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0118

EXPOSURE TO EVENING LIGHT, SLEEP INITIATION AND OBESITY IN ELDERLY INDIVIDUALS: A CROSS-SECTIONAL STUDY IN THE HEIJO-KYO COHORT

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Introduction: Light exposure before bedtime (evening light exposure) is common in modern society because of moderately high-intensity artificial lighting use. Evening light exposure may delay the subsequent sleep initiation, and poor sleep quality has been reported to disturb body mass regulation. However, the associations among evening light exposure, sleep initiation, and body mass remain uncertain.

Methods: In this cross-sectional study on 862 elderly individuals (mean age, 72.1 years), we measured light intensity during 4 h before bedtime and sleep onset latency (SOL) as indexes of evening light exposure and sleep initiation, respectively, for two consecutive days using a wrist actigraph incorporating a light meter and an accelerometer.

Results: The means for body mass index (BMI) and waist circumference (WC) were 23.1 kg/m² (SD, 3.0) and 84.0 cm (8.6), respectively. The medians for evening light intensity and SOL were 25.4 lux (interquartile range, 16.7 to 38.6) and 19.5 min (9.5 to 37.0), respectively. Univariate linear regression models revealed that log-transformed evening light intensity and log-transformed SOL were both significantly and positively associated with BMI and WC. In multivariate linear regression models mutually adjusted for age, gender, daytime physical activity, bedtime, log-transformed evening light intensity and log-transformed SOL, log-transformed evening light intensity and log-transformed SOL were significantly and independently associated with BMI (β , 0.426; 95% CI, 0.127 to 0.725; $P = 0.005$; and β , 0.220; 95% CI, 0.017 to 0.422; $P = 0.034$, respectively). Consistently, log-transformed evening light intensity and log-transformed SOL were also significantly and independently associated with WC (β , 1.395; 95% CI, 0.550 to 2.240; $P = 0.001$; and β , 0.773; 95% CI, 0.200 to 1.346; $P = 0.008$, respectively).

Conclusion: We demonstrated that evening light exposure and sleep initiation are significantly and independently associated with both BMI and WC in a general elderly population.

0119

CRY1 GENE POLYMORPHISM ASSOCIATED WITH MORNINGNESS-EVENINGNESS IN KOREAN ADULTS WITH THE DEFINITE MORNING AND EVENING TYPES

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Introduction: The morningness-eveningness (ME) refers to individual difference in preferred sleep-wake timing. After it was originally reported that the CLOCK gene polymorphism was associated with ME, there have been other studies on various genetic polymorphisms including PER and CK1 genes associated with ME and/or sleep timing. In gene-gene association studies, the best prerequisite for unequivocal results is optimal phenotyping. Since the Horne-Östberg Morningness-Eveningness Questionnaire (MEQ) has a limitation in actual phenotyping, we also measured the melatonin rhythm. We aimed to examine the

association of previously reported clock gene polymorphisms with ME in Korean adults.

Methods: Fifteen subjects with definite morning type (DMT) (Age: 24.1 ± 5.1 , M:F = 8:7) and 15 with definite evening type (DET) (Age: 22.1 ± 2.1 , M:F = 5:10) were recruited by using the Korean version of MEQ. Actigraphy data (Actiwatch-2, Philips-Respironics Co.) were collected for two weeks prior to the 24-hour laboratory study for each subject. Fifteen lux was maintained during waking period, and the saliva collection per hour in the semi-recumbent position was done 8 times until the individual habitual bedtime. Saliva melatonin levels were assessed by ELISA, and the dim light melatonin onset (DLMO) was defined as the time at which evening melatonin levels rose to more than two standard deviations above the average baseline level. Five single nucleotide polymorphisms (SNPs) (PER1 G2475T, PER1 C2485T, PER2 A2221G, CRY1 T2790G and CLOCK T3111C) were analyzed by SNaPshot assay. According to the H-W equilibrium, PER1 C2485T and CRY1 T2790G were finally analyzed.

Results: The mean DLMO of DMT subjects was significantly earlier than DET subjects ($p < 0.0001$). The genotypes and allele frequencies of CRY1 T2790G were significantly different between the DMT and DET groups ($p < 0.01$). However, those of PER1 C2485T were not. The Beck Depression Inventory (BDI) scores in the group of G allele positive for CRY1 T2790G were significantly lower than those of the G allele negative group ($p < 0.01$).

Conclusion: Our study showed that the G allele of CRY1 T2790G was associated with the morningness in Korean adults. Since we defined the phenotypes of ME based on the DLMO as well as the MEQ score for each subject, our result is considered more meaningful than those of previous gene-gene association studies.

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0120

CHARACTEROLOGICAL TRAITS IN MORNING, EVENING AND INTERMEDIATE CHRONOTYPES

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Introduction: A limited amount of research exists on the characterological presentations of chronotypes (morning-types, evening-types). While some studies have looked at which traits are more common amongst morning-types or evening-types, the results are inconclusive. Furthermore, most studies have focused primarily on the differences between morning-types and evening-types, and have overlooked those who do not fall in either category (intermediate-types). This study is designed to explore and compare personality factors among morning, evening, and intermediate-types.

Methods: Seventy-eight participants [33 M, 45 F; mean age 25.1 (7.8)] completed self-report questionnaires including the Morningness-Eveningness questionnaire (MEQ), Profile of Mood States (POMS), 16PF (personality inventory), and Procrastination Scale (PS).

Results: ANOVAs comparing the scores across the three groups (morning, evening, intermediate) revealed significant differences for Procrastination ($F = 8.4$, $p = .00$) and the Independence subscale of the 16PF ($F = 3.88$, $p = .03$). Post hoc analyses indicated that morning-types score significantly lower than evening-types and intermediate-types on the PS (Tukey HSD = -19.9, $p < .001$ and HSD = -14.7, $p < .03$, respectively). Morning-types also differed significantly from intermediate-types on the Independence subscale (HSD = 2.26, $p < .03$) and showed a trend with evening-types (HSD = 1.62, $p = .05$), with morning-types scoring higher on this scale.

Conclusion: Although current research has produced mixed results regarding the characterological presentations of chronotypes, preliminary results of this study are consistent with findings in the literature, suggesting that morningness is negatively related to procrastination. Furthermore, as intermediate-types are often excluded from chronotype research, these preliminary findings are compelling. The data suggests that morning-types may significantly differ from both intermediate- and evening-types on measures of personality and procrastination; therefore, the inclusion of intermediate-types in chronotype research may reveal additional significant differences amongst chronotypes and provide other information regarding the classification of chronotypes.

0121

THE SIGNIFICANCE OF SOCIAL JETLAG ON A COLLEGE CAMPUS

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Introduction: Social jetlag, a representation of the discrepancy in sleep timing practices, may lead to circadian dysregulation. This discrepancy may lead to shifts in many vital hormones, similar to what is experienced in shift workers. Although this potential consequence is of particular concern for college students given their tendency towards eveningness, no studies have described social jetlag among this population. The aim of the present study was to examine social jetlag among college students and to investigate its prevalence and severity in relation to gender and race/ethnicity.

Methods: College students were recruited from psychology classes ($N = 221$; 72.40% female; 55.70% Non-Hispanic White; 26.20% Asian; 5.90% African American; 3.60% Hispanic/Latino; 0.90% Native American; 6.30% Other). Participants completed the Sleep Timing Questionnaire, the Morningness-Eveningness Questionnaire (a measure of chronotype), and a demographic questionnaire. Social jetlag was computed by taking the absolute value of the difference between the midpoint of sleep on workdays (MSW) and free days (MSF), represented as $|\text{MSW} - \text{MSF}|$. Gender differences were evaluated using a t-test, and race/ethnicity differences were assessed using ANOVA and post-hoc tests.

Results: Over 75% of the sample demonstrated moderate to high levels of social jetlag: 62.00% reported moderate jetlag (0.53-2.50 h; -1 to +1 SD) and 13.10% reported high jetlag (> 2.50 h; $> +1$ SD). Differences according to race/ethnicity were found $F(5, 212) = 2.26$, $p = .05$. Post hoc tests showed greater social jetlag in Non-Hispanic White ($M = 1.03$ h, $SD = 0.57$) versus Asian ($M = 0.76$ h, $SD = 0.63$) students. No significant gender differences were found (males $M = 1.51$, $SD = 1.13$ and female $M = 1.52$, $SD = 0.94$).

Conclusion: Given the prevalence of moderate to high social jetlag in this population, information regarding social jetlag and sleep timing practices may be useful to incorporate into health psychoeducation for college students. Additionally, future studies should seek to clarify the relationship between social jetlag and race/ethnicity, as it may be beneficial to target psychoeducation to specific populations at greatest risk.

0122

SOCIAL JETLAG AND CHRONOTYPE AS RISK FACTORS OF SUBSTANCE USE AMONG COLLEGE STUDENTSCulnan E¹, Zamzow J¹, Mosti C¹, Daly BP¹, Grandner M², Kloss JD¹¹Psychology, Drexel University, Philadelphia, PA, USA, ²Center for Sleep and Circadian Neurobiology, University of Pennsylvania, Philadelphia, PA, USA

Introduction: Substance use among college students is a pervasive problem that results in numerous adverse psychosocial and health consequences. Eveningness is one factor associated with substance use. A related concept, social jetlag (the discrepancy in sleep timing practices) may be an additional risk factor, as it may compound the desynchrony associated with eveningness. Thus, social jetlag may be independently associated with emotional and physiological disruptions, thereby increasing students' likelihood of engaging in substance use. The current study was undertaken to determine the degree to which both chronotype and social jetlag confer risk for substance use.

Methods: College students (N = 237) completed several self-report measures including the Sleep Timing Questionnaire, the Morningness-Eveningness Questionnaire (a measure of chronotype), and the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST). Questions utilized from the ASSIST assessed whether participants had ever used marijuana, alcohol, and nicotine. Social jetlag was operationalized as the absolute value of the difference between the midpoint of sleep on workdays (MSW) and free days (MSF), represented as $[[MSW - MSF]]$. Binomial logistic regression analyses, with substance use as outcome, evaluated relationships to chronotype and social jetlag.

Results: Eveningness was associated with increased odds of alcohol use (OR = 2.16; 95%CI [1.23, 3.78]; $p < 0.01$). Each hour of social jetlag was associated with increased odds of nicotine use (OR = 1.50; 95%CI [1.31, 2.00]; $p < 0.01$), alcohol (OR = 1.60; 95%CI [1.10, 2.32]; $p = 0.01$), and marijuana (OR = 1.62; 95%CI [1.21, 2.17]; $p < 0.01$). Additionally, effects for social jetlag persisted in the presence of eveningness for nicotine (OR = 1.50; 95%CI [1.123, 2.00]; $p < 0.01$), alcohol (OR = 1.53; 95%CI [1.05, 2.23]; $p = .03$), and marijuana (OR = 1.58; 95%CI [1.18, 2.12]; $p < 0.01$).

Conclusion: Both social jetlag and chronotype were associated with alcohol, yet only social jetlag was associated with marijuana and nicotine. These findings suggest that staying up late (which may accompany higher degrees of eveningness and jetlag) increases the likelihood of alcohol use, whereas disrupting certain systems by shifting sleep (e.g., mood, alertness) may increase the likelihood of using marijuana and nicotine.

0123

CHRONOTYPE, SLEEP QUALITY AND EXTINCTION MEMORY: AN ACTIGRAPHIC STUDYPace-Schott EF¹, Rubin Z¹, Verga PW², Spencer RM², Orr SP¹, Milad MR¹¹Psychiatry, Harvard Medical School, Charlestown, MA, USA,²Psychology, University of Massachusetts, Amherst, MA, USA

Introduction: Extinction is better learned in the morning. Morning testing promotes generalization of extinction memory. We examined the effect of chronotype on extinction learning and memory.

Methods: 96 healthy males wore the Actiwatch2 making event marks when beginning to attempt sleep and waking for the day. 85 individuals (aged 18-29, mean 21.1, SD 2.7) produced 4-9 usable nights (mean 7.0, SD 1.0, 91% > 5 nights, 86% > 6). Participants wore Actiwatch 7-9 days during which they were asked to abstain from naps, recreational drugs and alcohol, go to bed before 2 AM and allow a minimum 7-hr sleep opportunity. Midpoint between sleep onset and waking event mark (or diary entry when missed) served as binary proxy for Chronotype

("Owls" vs. "Larks") using median split of minutes past midnight. Skin-conductance response (SCR) was conditioned, using a mild shock, to 2 differently colored images of lamps (CS+) but not a third (CS-). Immediately afterward, one CS+Type (CS+E), but not the other (CS+U) was extinguished by un-reinforced presentations (Extinction Learning). After a delay (3, 12 or 24 hr), all 3 CS were presented (Extinction Recall). Differential SCR (CS+ - CS-) was computed using square-root transformed SCR.

Results: Midpoint correlated significantly with Morningness-Eveningness Questionnaire ($R = .38$, $p = .0006$). For Extinction Learning, 2-factor ANOVA showed a significant Time-of-Day \times Chronotype interaction [$F(1,80) = 4.15$, $p = .045$]; only Larks showed significantly better Extinction Learning in Morning [$F(1,41) = 8.63$, $p = .005$]. At Extinction Recall, among those who learned and recalled extinction at the same time of day (3 and 24-hr), there was a significant CS+Type \times Chronotype interaction [$F(1,47) = 7.12$, $p = .01$]; only Owls showed a greater response to the CS+U vs. CS+E [$F(1,25) = 10.87$, $p = .003$]. This interaction did not further interact with an also-significant [$F(1,47) = 5.27$, $p = .026$] CS+Type \times Time-of-Day interaction ($p = .18$).

Conclusion: Larks but not Owls learn extinction better in the morning. Larks also generalize this memory better at recall regardless of time-of-day.

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0124

CIRCADIAN CHRONOTYPE AND PERFORMANCE ON NEURO-COGNITIVE TESTS IN THE WISCONSIN SLEEP COHORT

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Introduction: Extreme circadian chronotypes in conflict with societally imposed sleep-wake schedules are hypothesized to affect cognitive functioning. Although test performance and school grades have been reported to vary by chronotype, research is sparse and focused on younger populations. We explored differences in neurocognitive test performance by chronotype indicated by the Morningness-Eveningness Questionnaire (MEQ).

Methods: The sample comprised 946 men and women, ages 35-72 years, in the Wisconsin Sleep Cohort, a longitudinal study of sleep problems in the general population. Participants completed the MEQ and six neurocognitive tests—conducted in the early evening—assessing memory, learning, attention, executive function, and psychomotor efficiency. Test scores were compared by chronotype, using continuous and categorical MEQ variables. Using multiple line regression, the associations of MEQ scores with test performance were adjusted for age, sex, and education.

Results: Unadjusted test scores by MEQ quintiles showed inverse trends of higher test scores with MEQ quintile, with the "most eveningness" quintile having the best scores and "most morningness" the worst. After covariate adjustment, only four scales of the Auditory Verbal Learning Test (AVLT) showed significant trends across MEQ quintiles: Recognition ($p = 0.05$), Learning ($p = 0.04$), Retention ($p = 0.005$), and Delayed recall ($p = 0.003$). Other tests neurocognitive tests were not significantly associated with MEQ. Education, shift work and usual sleep duration did not modify associations.

Conclusion: The morningness-eveningness chronotype spectrum was related to performance on auditory-verbal learning and memory tests. "Most-eveningness" had highest adjusted scores on the AVLT, possibly indicating better short-term auditory-verbal memory, learning, and information retention. Time of day of test administration may have favored performance of the eveningness chronotype. However, such an effect would have been specific to the AVLT, as five other neurocognitive tests did not vary by chronotype. The findings suggest chronotype

has selective effects on cognitive performance, and underscore the need for further research.

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0125

EVENINGNESS CHRONOTYPE AND REM-RELATED PHENOMENA IN THE WISCONSIN SLEEP COHORT

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Introduction: “Most eveningness” chronotype is linked to conflicts of biological clock timing with societal demands and with maladaptive sleep habits, but these relationships are poorly understood. It has been hypothesized that misalignment of sleep time with sleep state may increase REM-related phenomenon, including nightmares. We explored the association of the frequency of experiencing these events with most eveningness (“owls”) compared with most morningness (“larks”) chronotypes.

Methods: Participants (n = 1152) in the Wisconsin Sleep Cohort, a longitudinal population based study of sleep in adults (ages 35-72, 54% men), completed the Morningness-Eveningness questionnaire (MEQ) to measure chronotype, and reported the frequency, on a weekly/monthly semiquantitative scale, that they experienced sleep paralysis, hypnagogic hallucinations, cataplexy-like feelings (e.g., weak knees when emotional), and nightmares. Chronotype was characterized categorically by quintiles of the MEQ with the lowest quintile designated “owls” and the highest quintile “larks.” Multiple logistic regression modeling was used to estimate the odds of experiencing the REM phenomena sometimes or often versus never or a few times ever, for “owls” versus “larks,” adjusted for potential confounding and mediating factors.

Results: Compared to “larks,” the “owls” reported a significantly higher occurrences of sleep paralysis (odd ratio [95% CI] = 4.6 [1.2, 12.0]), hypnagogic hallucinations (OR = 2.2 [1.2, 4.5]), cataplexy-like experiences (OR = 2.2 [1.1, 3.8]), and nightmares (OR = 2.1 [1.0, 4.5]). The associations adjusted for potential confounding factors and, furthermore, were not explained (mediated) by shift work or usual sleep duration.

Conclusion: “Owls,” compared to “larks,” were 2.1-4.6 times more likely to experience REM-related phenomena. Sleep deprivation has been linked to sleep paralysis, but sleep duration did not explain the associations found in our study. Although underlying mechanisms for these associations are not clear, the REM-related experiences are likely to adversely affect well-being and behavioral outcomes of the most-eveningness (“owls”) chronotype.

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0126

SEX DIFFERENCES IN SLEEP QUANTIFIED USING SURVIVAL ANALYSES OF SLEEP AND WAKE BOUTS: A META-ANALYSIS ACROSS FORCED DESYNCHRONY PROTOCOLS

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Introduction: While women are more likely to report sleep complaints than men, their objectively defined sleep is typically not worse than men’s. Sleep timing and structure are affected by prior wake duration, length of time in current sleep episode and circadian phase. We conducted a meta-

analysis based on survival analyses to quantify sex differences in sleep dynamics from sleep episodes distributed across the full circadian cycle.

Methods: Thirteen female and forty male participants ages 19-30 or 64-74 years and with no medical, psychological or sleep disorders and free of medications and caffeine were studied in inpatient protocols with 3 different sleep/wake (T) cycle durations each with a 2:1 wake:sleep ratio: T = 20 hr (Wyatt 1999), T = 28 hr (Gronfier 2007, Dijk 1999), T = 42.85 hr (Wyatt 2004, Grady 2010). Sleep was scored using Rechtschaffen and Kales criteria. Cox Proportional Hazard Regression Models for clustered data were performed for Wake, Sleep (NREM+REM), NREM Sleep and REM Sleep bouts. There was a minimum bout length of 1 minute. Age group (young or old) and T cycle duration were covariates.

Results: Women had statistical longer (P < 0.001) Sleep, NREM and REM bouts than men after adjustments for age group and T cycle. There were no differences for Wake bout duration.

Conclusion: Survival based analyses provided evidence for a sex difference in sleep bout duration between healthy women and men without sleep complaints when sleeping across circadian phases.

Support (If Any): NSBRI HFP02802, NIH R01-HL114088, K24-HL105664, P01-AG009975, R01-GM105018 plus grants supporting the original research.

0127

EVALUATION OF THE EFFECT OF CONCOMITANT CONSUMPTION OF TASIMELTEON AND ETHANOL ON COGNITIVE FUNCTION, BALANCE AND SUBJECTIVE MEASURES IN HEALTHY SUBJECTS

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Introduction: Tasimelteon, a Dual Melatonin Receptor Agonist (DMRA) with selective agonist activity at both melatonin receptors, is in development for the treatment of Non-24-Hour Disorder (Non-24) in the totally blind. Non-24 is a severe chronic circadian rhythm disorder that occurs when individuals are unable to entrain their endogenous master body clock to the 24-hour day-night cycle. Tasimelteon resets the master body clock in the suprachiasmatic nucleus. Due to tasimelteon’s central mechanism of action, the possibility of a pharmacodynamic potentiation of ethanol effects was investigated.

Methods: The pharmacodynamic interaction between tasimelteon and ethanol was assessed in a single-center, randomized, double-masked, 4-period crossover study. Twenty-eight healthy volunteers received all four treatments: 20 mg tasimelteon, 0.6 g/kg ethanol (female) or 0.7 g/kg ethanol (male), 20 mg tasimelteon + 0.6 g/kg ethanol (female) or 0.7 g/kg ethanol (male), and placebo. Pharmacodynamic assessments were measured pre-dose and periodically for 24 hours post-dose utilizing the Digit Symbol Substitution Test (DSST), Digit Vigilance Test (DV), Hopkins Verbal Learning Test, Revised (HVLT-R), Divided Attention Test (DAT), Choice Reaction Time (CRT), Visual Analog Scales (VAS), and Balance Platform Test.

Results: Ethanol but not tasimelteon affected most variables of the DAT, VAS, and balance platform studied (p < 0.05). The effect of tasimelteon + ethanol was not significantly different from ethanol alone on any of these variables, except on the Feeling Sick VAS (p < 0.001). All treatments, except placebo, affected the DSST symbols completed but the effect was not meaningfully different between tasimelteon + ethanol and ethanol alone (p = 0.05). Only ethanol affected response time CRT (p = 0.022). None of the treatments had an effect on DV or HVLT-R.

Conclusion: Co-administration of tasimelteon does not appear to potentiate the effects of alcohol on cognition, balance, or subjective measures. Tasimelteon administered with ethanol was generally considered safe.

Support (If Any): Vanda Pharmaceuticals Inc.

0128

STABILITY OF ENERGY BALANCE RESPONSES TO SLEEP RESTRICTION OVER LONG TIME INTERVALS

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Introduction: We have recently shown that sleep restriction (SR) leads to weight gain, increased caloric intake and late-night eating. However, not all subjects respond to SR to the same degree (e.g., some gain a significant amount of weight while others maintain or lose weight). The aim of the current study was to examine if the weight gain and caloric-intake responses to SR are stable over time.

Methods: N = 17 healthy subjects (22-50 y, 19-30 BMI, 8 females) participated in a protocol including 2 baseline nights (BL1-2; 10-12 h time in bed [TIB]/night) followed by 5 consecutive SR nights (4 h TIB/night) during two separate laboratory experiments. Of these subjects, caloric intake was measured during both occasions for n = 10 (4 females). The duration between the two experimental exposures to SR ranged from 1.7 to 68.5 months (median = 10 months). Weight was measured at protocol admittance and discharge. Food/drink consumption was ad libitum and the amount and time each item was consumed was recorded daily. The intraclass correlation coefficient (ICC) for each measure was computed as the ratio of between-subjects variance to the sum of the between- and within-subjects variances.

Results: Although there was considerable variability between subjects in terms of weight gained during the study and increased caloric intake during SR, there was considerable stability within subjects, as evident by high ICCs: weight change during the study (ICC = 0.79), increased caloric intake during SR (SR intake – BL intake, ICC = 0.70), and caloric intake during late-night hours (2200-0400 h, ICC = 0.94).

Conclusion: As is true for neurobehavioral measures, the energy balance response to sleep restriction may be a trait-like characteristic with certain individuals more prone to weight gain, increased caloric intake and late-night eating than others. The results are relevant for predicting energy balance responses in individuals who are exposed to acute SR, chronically or intermittently, across months and years.

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0129

SLEEP PATTERNS DURING DUTY PERIODS AND RESTART BREAKS IN A FIELD STUDY OF COMMERCIAL MOTOR VEHICLE DRIVERS

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Introduction: Commercial Motor Vehicle (CMV) drivers with nighttime work schedules have restricted sleep due to circadian misalignment of their sleep schedules. In the US, after accumulating 70 h of duty time, CMV drivers must take a minimum of 34 h off duty to recuperate—a so-called “restart break.” For nighttime drivers, a 34 h restart break contains only one night for sleep recuperation. Evidence from laboratory studies shows that this does not suffice to recycle to the next duty period with optimal alertness. Informed by this evidence, US hours-of-service regulations for CMV drivers were recently changed to require nighttime drivers to extend their restart break to include at least two nighttime periods (01:00-05:00). The effectiveness of this change has been questioned

with anecdotal reports suggesting that in real-world operations, nighttime drivers continue to sleep during the day in their restart breaks. To investigate this in the field, we measured CMV drivers' sleep schedules while on duty and during restart breaks by means of actigraphy.

Methods: N = 106 CMV drivers (ages 24-69, 6 females) logged their duty times, kept a sleep diary, and wore a wrist actigraph (Actiwatch 2, Respironics) throughout two consecutive duty periods and the intervening restart break. Their 24 h sleep profiles were assessed from the actigraph records in conjunction with the diaries. Drivers were divided into three categories based on their predominant duty schedules. Daytime drivers began their shifts after 04:30 and ended before 24:00. Nighttime drivers began their shifts between 15:00 and 04:30. Individuals not fitting these patterns for > 3 days were classified as mixed-schedule drivers. For these three categories, average 24 h sleep profiles were compared between duty periods and restart breaks using mixed-effects ANOVA.

Results: There were significant ($P < 0.001$) effects for time of day ($F = 23.7$), time of day by group interaction ($F = 12.5$), time of day by period (duty or restart) interaction ($F = 2.2$), and three-way interaction ($F = 1.8$). During duty periods, sleep was most prevalent at night around 03:00 for daytime and mixed-schedule drivers and during the day around 11:30 for nighttime drivers. However, during the restart break, sleep was most prevalent at night, between 02:00 and 06:00, for all three driver categories.

Conclusion: These results do not support anecdotal reports that CMV nighttime drivers maintain a daytime sleep schedule during restart breaks. Nighttime drivers in this study reverted to a nighttime sleep schedule during their restart breaks, consistent with sleep and circadian neurobiology.

Support (If Any): FMCSA award DTMC75-07-D-00006.

0130

HOMEOSTATIC AND CIRCADIAN VARIATION IN THE MULTIPLE SLEEP LATENCY TEST IN YOUNGER AND OLDER ADOLESCENTS DURING 28H FORCED DESYNCHRONY

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Introduction: Homeostatic and circadian factors influence sleep propensity, though the relative contribution of each factor during development is unknown. We measured sleep propensity in adolescents using the multiple sleep latency test (MSLT) across varying levels of homeostatic pressure and at different circadian phases during a 28 h forced desynchrony (FD) protocol.

Methods: Twenty-seven healthy adolescents (ages 9.6-15.2 years, mean = 12.8 SD = 1.6 years; 16 females) participated in a 3-week laboratory study which included 12 cycles of 28 h FD. Each cycle included 16h20m wake to 11h40m sleep opportunity. Lights were maintained at < 20 lux during scheduled wake and < 1 lux during scheduled sleep. Circadian phase was calculated by salivary melatonin onset measured across FD cycles. The MSLT was administered 2.5 h after scheduled wake and thereafter every 2 h during scheduled wake periods. Participants lay in a dark room with their eyes closed and were instructed to try to fall asleep while being measured with standard polysomnography. The test was terminated after 3 consecutive 30-second epochs of sleep or 20 m if sleep was not achieved. Sleep latencies were transformed to z-scores for each participant and averaged into 2 h homeostatic and 60-degree circadian bins across all FD cycles. Mixed effects modeling was used to compare MSLT z scores between younger and older adolescents (grouped by median split at 13.0 years).

Results: We found significant main effects for homeostatic load and circadian phase ($F[6,2367] = 158.58$, $P < 0.001$; $F[5,2367] = 300.43$,

$P < 0.001$). Participants demonstrated greater sleep propensity the longer they were awake and during the circadian night. There was a significant interaction of age group and circadian phase, whereby the younger group had increased sleep propensity relative to the older during the circadian night ($F[5,2367] = 5.32$, $P < 0.001$). A significant interaction of circadian phase and homeostatic load indicated an increase in the effect of circadian phase on sleep propensity as homeostatic load increased ($F[30,2367] = 5.13$, $P < 0.001$). We did not find a significant main effect for age group nor a significant interaction of homeostatic load and age group.

Conclusion: All adolescents demonstrated greater sleep propensity with increased homeostatic load and during the circadian night. Circadian variation in sleep propensity was more pronounced as homeostatic load increased. The younger participants showed greater sleep propensity during the circadian night relative to the older participants despite the same sleep opportunities.

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0131

PER3 VNTR: SLEEP PATTERNS AND DEPRESSED MOOD IN COLLEGE STUDENTS

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Introduction: The human PER3 variable number tandem repeat (VNTR) polymorphism is thought to play a role in circadian timing and sleep-wake homeostasis. In general, homozygosity for the 5-repeat allele is associated with morning phase preference and susceptibility to performance decrements in response to sleep deprivation. We examined whether depressed mood scores were influenced by sleep patterns or circadian phase as a function of PER3 genotype.

Methods: Participants were 565 (ages 18-21; mean age 18.6 y; 59% female) first-year college students who provided cheek cells for DNA extraction, completed daily on-line sleep logs for the first 8-9 weeks of college, and completed a depression scale (CES-D) at the end of week 9. A subset ($n = 299$; 57% female) also provided saliva samples for determination of melatonin onset phase (DLMO) at about week 7. PER3 VNTR genotype was performed with standard methods. Sleep diary variables analyzed included: mean bedtime (BT), rise time (RT), and total sleep time (TST). Separate moderator analyses for CES-D scores examined PER3 5/5 versus carriers of the PER3 short variant allele (PER3 4/5 or PER3 4/4) for DLMO, BT, RT, and TST.

Results: A significant interaction of PER3 genotype with DLMO indicated higher CES-D in those with PER3 5/5 in the presence of later DLMO ($F = 6.60$, $p = .01$). Statistically significant interactions of sleep variables with PER3 genotype included: mean BT (later BT with PER3 5/5 had higher CES-D; $F = 4.28$, $p = .015$); mean RT (later RT with PER3 5/5 had higher CES-D; $F = 5.69$, $p = .017$). Mean TST showed no significant interaction.

Conclusion: These findings indicate that PER3 VNTR genotype moderates the association of circadian phase and sleep timing with depressed mood symptoms. In general, those homozygous for the PER3 long allele (5/5) who had later DLMO phase or later sleep timing reported more symptoms of depressed mood.

Support (If Any): R01MH079179.

0132

DNA METHYLATION ASSOCIATED WITH SLEEP DURATION: PRELIMINARY RESULTS

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Introduction: Sleep duration and timing have genetic underpinnings and are regulated by circadian timing and sleep homeostasis. Few studies have examined whether specific sleep patterns are related to epigenetic modification. We present preliminary analyses examining methylation in blood samples from first-year college students.

Methods: Participants (mean age 18.5 y) kept daily on-line sleep logs for the first 8-9 weeks of college; blood samples were obtained at weeks 1 and 9. Sixteen participants (6 men) were chosen who had high (> 16) depressed mood scores on the CES-D questionnaire and either shorter (< 6.8 h) or longer (> 7.8 h) mean daily total sleep time across the semester. Two methylation analyses were done. Analysis 1 compared participants with longer sleep to those with shorter sleep with methylation index for pooled DNA from the week-9 blood sample using the Illumina whole-genome DNA methylation array. Analysis 2 compared global methylation changes between the week-1 and week-9 blood samples from three longer-sleep and three shorter-sleep participants.

Results: Analysis 1 showed that 87 of 485,577 CpG sites demonstrated statistically significant differential methylation between sleep groups. Hypermethylation at 59 sites and hypomethylation at 28 sites were observed in the shorter vs longer sleep group. These differential methylation sites were located in 48 unique genes including several HLA-related genes, DNA repair gene XRCC2, oncogene YES1, and circadian related gene NPY. This set of genes was further investigated for functional inter-relatedness using the IPA pathway analysis tool, and a network related to "Cancer, Immunological Disease, and Connective Tissue Disorders" was identified. For Analysis 2, longer sleep participants showed an overall decrease in methylation; shorter sleep subjects showed increased methylation.

Conclusion: Our findings showed that shorter and longer sleeping young adults with symptoms of depressed mood showed different patterns of DNA methylation for 87 CpG sites across 48 genes. In addition, we found that short-term differences in sleep duration can have significant consequences for methylation patterns throughout the genome. Although the global methylation approach lacks resolution to detect differences at the individual gene level, these results provide support for future work examining the epigenetics of sleep and mood.

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0133

SLEEP-WAKE SYNCHRONY IN COUPLES IS ASSOCIATED WITH RELATIONSHIP FUNCTIONING

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Introduction: Social interactions can entrain the circadian system. Synchrony in sleep-wake patterns may, in turn, be an index of normative, healthy attachment in close adult relationships. However, we know little

about adult attachment and synchrony in couples' circadian rhythmicity. We examined whether partners' attachment style and marital adjustment was related to their degree of synchrony in daily rhythmicity and actigraphy-assessed sleep-wake patterns.

Methods: Each member of 46 couples completed an assessment of avoidant and anxious attachment style, and marital adjustment. Couples completed a daily 5-item Social Rhythm Metric (SRM) and wore actigraphy devices over a 10-day period. Synchrony in sleep-wake patterns, or concordance, was calculated in 60-second epochs for each sleep period. Percent concordance was defined as (#concordant epochs/#total epochs)*100, and ranged from 53-88% (mean 74.8, SD 7.22). Data were analyzed using correlation, regression, and mixed modeling.

Results: SRM scores between husband and wives were highly correlated ($r(46) = .572, p < .001$); however, attachment or adjustment was not related to concordance in SRM scores. Husband anxious attachment predicted higher actigraphy concordance, $B = 4.03, t(42) = 2.21, p = .03$. This was moderated by wives' marital adjustment, $B = -.435, t(40) = -2.66, p = .01$. Better adjustment in wives was associated with higher concordance; low anxious attachment in husbands and low wife marital adjustment was associated with lower concordance. Wife attachment style and avoidant attachment styles in husbands were not related to concordance.

Conclusion: Relationship factors were not associated with agreement in overall daily rhythmicity, but were associated with sleep-wake concordance. Concordance was higher among wives with higher marital adjustment scores, regardless of husbands' attachment style. Sleep-wake synchrony may serve as a novel index of relationship functioning in couples. Conversely, attention to relationship functioning may provide a new avenue for improving the sleep of individuals and couples.

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0134

THE SLEEP PROMOTING EFFECT OF DORA-12 IS SEX AND ESTRADIOL DEPENDENT

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Introduction: Sleep disruptions are more commonly reported in women compared to men and typically coincide with periods of hormonal fluctuations like during the menstrual cycle, pregnancy or menopause. We have previously shown using a rat model that sex differences in sleep are due to effects of estradiol (E2) on sexually differentiated brain circuitry. These findings raise the possibility that the efficacy of sleep promoting drugs may be different in males and females and that E2 may modulate drug efficacy. Data from our laboratory suggest that orexin, a key neuropeptide involved in arousal, mediates E2's suppression of sleep. Here, we test the prediction that sleep promotion by dual orexin receptor antagonists (DORA-12, a gift from Merck) will be sex and E2 dependent.

Methods: Gonadectomized female and male rats were fitted with EEG/EMG transmitters (Data Sciences International) and randomly assigned to either DORA-12 or vehicle treatment groups. DORA-12 (30 mg/kg) or vehicle was given orally prior to lights out (ZT12) each day. Females received an oil injection and then two doses (5 µg and 10 µg) of estradiol benzoate 24 hrs apart at ZT21, while males received only oil injections. Mean time in wake, NREM and REM sleep was determined for the 12 hr dark period designated baseline and E2-day.

Results: As previously shown, DORA-12 significantly suppressed wake in males 3-4 hr post-administration. Wakefulness returned to VEH levels by ~ZT15. Surprisingly, wake suppression and consequently increased sleep in both oil and E2-treated females were steady across

the 12 hr dark phase following DORA-12 administration. However, the magnitude of the sleep suppression was significantly attenuated in females treated with E2 and DORA-12. The effects of DORA-12 were significantly suppressed by E2 in the first 6 hr following administration.

Conclusion: Our data suggest that the efficacy of DORA-12 is sex and E2 dependent. Sex differences in sleep circuitry and/or drug metabolism may contribute to increased sleep promotion in females compared to males.

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0135

RELATIONSHIP OF SLEEP AND WAKE BOUTS IN DROSOPHILA

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Introduction: The mechanism of sleep and wake regulation is not well understood. Many statistical approaches have analyzed data in a way that bout relationships are lost. Our approach has been to use mathematical modeling of fly sleep to understand if there is a pattern and dependence on how sleep and wake bouts are related in normal flies and circadian disrupted flies.

Methods: We recorded activity from male and female wild-type flies and circadian clock mutants, cycle (cyc01), using Drosophila Activity Monitor system in one minute bins with the beam in a position that resulted in activity profiles that mimicked those of video recording. Flies were placed in constant darkness (DD) for 2 days and recorded for 4 days under DD. Sleep was defined as 5 continuous minutes of inactivity. We applied time series and exponential models to determine the relationships between prior and current bout lengths.

Results: By standardizing bouts by each individual's average bout length we decreased inter-individual variability. Standardization improved our exponential modeling of bout relationships, which revealed a negative relationship between past wake and current sleep bouts in all genders and genotypes tested except for cyc01 males. The negative relationship for the current sleep bout went as far back as 8 wake bouts. This unintuitive relationship was partly explained after plotting the bout relationships over time, which suggested that a particular pattern of short transitions may precede long sleep bouts. Contour plots of the actual data show a complex, non-linear relationship between past wake bouts and the current sleep bout.

Conclusion: We found that standardization of individual data decreased variability by describing bouts that were either longer or shorter for that individual fly. Our modeling suggests there is a relationship between preceding bouts, but it has negative influence and is complex, even in female flies without a circadian rhythm.

0136

ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND SLEEP IN HEALTHY TODDLERS

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Introduction: Disturbed sleep and reduced physical activity levels are hypothesized to promote risk for overweight/obesity. Although child-

hood obesity is a significant epidemic, associations between physical activity and sleep in young children are largely unknown.

Methods: Healthy toddlers aged 30-36 months ($n = 12$; 6 females) were studied while sleeping on their habitual schedule for 3-5 days, including a daytime nap opportunity and nighttime sleep. The timing of sleep and wakefulness was measured via actigraphy and parental sleep diaries. Minute-by-minute actigraphy data quantified physical activity levels. Activity periods were defined by wake start and end times and verified with parent-reports. Actigraphic estimates of total sleep time, sleep minutes, sleep onset latency, fragmentation index, and sleep percentage were computed. Pearson correlations were used to examine relationships between waking activity and sleep.

Results: Toddlers with higher summed morning activity had a shorter latency to sleep ($r = -0.33$; $p = 0.021$) and increased fragmentation ($r = 0.34$; $p = 0.015$) during their subsequent daytime nap. Higher summed afternoon activity was associated with greater fragmentation ($r = 0.42$; $p = 0.004$), decreased total sleep time ($r = -0.37$; $p = 0.014$), decreased sleep minutes ($r = -0.54$; $p < 0.001$), and decreased sleep percentage ($r = -0.35$; $p = 0.02$) during the following nighttime sleep period. Increased fragmentation ($r = 0.41$; $p = 0.005$), decreased sleep minutes ($r = -0.35$; $p = 0.020$), and decreased sleep percentage ($r = -0.52$; $p < 0.001$) during the night were associated with increased mean activity the following morning.

Conclusion: Findings from this study suggest bi-directional relationships between physical activity and sleep. Whether these associations are accounted for by a third underlying individual difference characteristic (e.g., temperament, non-exercise activity thermogenesis) warrants further investigation. Future studies should experimentally test associations between physical activity levels and sleep EEG measures (e.g., slow-wave activity, sleep stages), as well as longitudinal effects across development.

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0137

EARLY TO BED, EARLY TO RISE MAKES EASIER TO EXERCISE: THE ROLE OF SLEEP TIMING IN PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR

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Introduction: Later sleep timing has been associated with poorer health behaviors, yet few studies have evaluated sleep timing and physical activity. The goal of this study was to evaluate the relationship between sleep timing with self-reported and objective physical activity and sedentary time.

Methods: Participants included 123 healthy adults ($M = 24$, $SD = 6.8$ years, 71 f/53 m) with self-reported sleep duration ≥ 6.5 hours. Participants completed questionnaires and 7 days of wrist actigraphy (Actiwatch Spectrum, Philips). Actigraphy was scored using Actiware (version 5.71) and sleep diaries to calculate the following variables: sleep onset, sleep offset, sleep duration, wake after sleep onset sleep efficiency and activity counts. Physical activity was measured by the International Physical Activity Questionnaire (walking, moderate, vigorous physical activity, minutes sitting weekday and weekends). Participants also completed a self-efficacy for physical activity measure (ability to stick to and make time for exercise) and an 8 item measure of barriers to physical activity. Analyses included Pearson correlations and multiple regression analyses.

Results: Average sleep duration was 396 ($SD = 61$) min, sleep start was 12:57 AM and sleep end was 8:04 AM. Based on self-report 80% of the sample had high activity levels (≥ 1500 METS per week). Sleep

measures were not associated with minutes of self-reported activity or activity counts. Later sleep times were associated with more self-reported minutes sitting overall and on weekdays ($p < .05$). Sleep timing remained a significant predictor of sedentary minutes in regression equations controlling for age and sleep duration ($p < .05$). Sleep timing was associated with lower physical activity self-efficacy and greater barriers, including lower reported ability to stick to, make time for exercise (p values $< .01$), feeling discouraged by others ($p < .05$) and not having enough time for exercise ($p < .05$).

Conclusion: Later sleep timing was associated with greater sedentary minutes and perceived challenges for engaging in exercise but not with objective or self-reported physical activity minutes in healthy adults. This suggests that taking sleep timing into account when designing exercise interventions may be helpful for improving adherence.

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0138

BASELINE SLOW-WAVE SLEEP NEGATIVELY RELATES TO ENERGY BALANCE RESPONSES DURING SLEEP RESTRICTION IN HEALTHY ADULTS

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Introduction: Sleep restriction (SR) leads to increased daily caloric intake, late-night eating and weight gain. However, not all subjects respond to SR to the same degree (some gain a significant amount of weight while others maintain or lose weight). The amount of time spent in sleep stages 3 or 4 (slow-wave sleep [SWS]) is stable and trait-like within individuals but highly variable between individuals. The current study examined if individual differences in baseline SWS associated with energy balance responses to SR.

Methods: $N = 36$ healthy subjects (31.1 ± 8.3 y, 25.8 ± 2.7 BMI, 20 females) participated in a laboratory protocol including 2 baseline nights (BL1-2; 10-12 h time in bed [TIB]/night) followed by 5 consecutive SR nights (4 h TIB/night). Polysomnography was recorded on BL2 and scored using standard criteria. Duration of each sleep stage was calculated as a percent of total sleep time (%TST). Weight was measured at admittance and discharge. Food/drink consumption was ad libitum and recorded daily. Partial correlations controlling for age, gender, race and BMI were used for analyses.

Results: Subjects consumed 20.8% more calories during SR than during BL, ate/drank 507.3 ± 274.9 calories during late-night hours (2200-0400 h) and gained 0.61 ± 1.88 kg during the study. Baseline SWS ranged from 1.6-28.8% of TST and was negatively correlated with increased caloric intake during SR ($r = -0.45$, $p = 0.011$), late-night intake ($r = -0.41$, $p = 0.03$) and weight gain ($r = -0.48$, $p = 0.006$). No other sleep variables were significantly related to all three energy balance variables; however, stage 1 %TST was positively associated with increased caloric intake during SR ($r = 0.41$, $p = 0.02$), sleep efficiency was negatively related to late-night intake ($r = -0.39$, $p = 0.03$) whereas sleep latency was positively related to late-night intake ($r = 0.38$, $p = 0.04$), and stage 2 %TST was positively associated with weight gain ($r = 0.39$, $p = 0.03$).

Conclusion: Adults with less slow-wave sleep may be more vulnerable to increased daily caloric intake, late-night eating and weight gain during sleep restriction.

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0139

NUTRITIONAL INTAKES AND PHYSICAL ACTIVITY IN MIDDLE-AGED FINNISH MEN WITH AND WITHOUT INSOMNIA

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Introduction: Sleep disorder such as insomnia impairs one's physiological and psychological wellbeing thus affects our work efficiently and life quality. Obesity is a major risk factor for insomnia. In this study we aimed to identify if insomnia is related with daily diet and energy consumption.

Methods: The participants consist of 191 Finnish men, included diagnosed insomnia (n = 67, 50.7 ± 10.2 yrs, BMI = 29.5 ± 3.8), overweight/obese otherwise healthy (HO = 76, 50.5 ± 6.8 yrs, BMI = 28.1 ± 2.6), and healthy with normal weight (HN = 48, 50.9 ± 6.8 yrs, BMI = 23.4 ± 1.1). Dietary intakes were collected by three-day food records. Macro- and micro-nutrients were calculated by Micro-Nutrica PC Program. Physical activity including exercise and other daily activities were collected by questionnaires and energy expenditures were calculated based on duration and frequency of physical activities. One-way ANOVA and Generalized Estimation Equation model were used to test group differences.

Results: The insomnia group consumed higher fats (36.5 E%) and saturated fatty acids (14.5 E%) compared to the HO (32.6 E%) and 12.6 E%) and HN (31.5 E% and 12.4 E%) in total energy intake, respectively (P < .05 to < .01), while the insomnia group consumed lower carbohydrates (40.4 E%) than HO (45.3 E%) and HN (47.3 E%) groups (P < .005). The insomnia group also had lower intakes of vitamin B1, folate, vitamin C, and magnesium than the HO and HN groups (p < .05 to < .01). Fiber intake was higher in HN than insomnia (P = .014), and vitamin B6 was higher in HO than insomnia group (P = .001). In addition, the insomnia group had lower exercise energy expenditure than both HO and HN groups (MET mins/wk = 790 vs. 2040 and 2580; P < .001). No significant differences in commute, house work, and sedentary energy expenditures were found among the groups.

Conclusion: Intake of higher fat, especially saturated fat in combination with lower carbohydrate and several micro-nutrients in addition to low level of exercise may enhance the risk of insomnia.

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0140

SUBJECTIVE SLEEP QUALITY IN ELITE ATHLETES COMPARED TO NORMAL CONTROLS ON THE PITTSBURGH SLEEP QUALITY INDEX

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Introduction: Previous research examining sleep in athletes has suggested that elite athletes have reduced sleep quality compared to controls. Here we compared the sleep of elite athletes and normal controls using the Pittsburgh Sleep Quality Index (PSQI).

Methods: 63 National and Olympic winter team athletes (aged 26.0 ± 4.0; 32% females) from the Canadian Sport Centre Calgary completed the

PSQI and the Athlete Morningness Eveningness Scale. They were compared to 83 healthy, normal sleepers (aged 27.3 ± 4.7; 51% females) from studies at Washington State University's Sleep and Performance Research Center who completed the PSQI and the Composite Scale of Morningness. For comparability, morningness scores were classified in 9 equal intervals for both morningness questionnaires. Using Kolmogorov-Smirnov tests, the two groups were compared for age, gender, PSQI global scores, PSQI component scores (sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction), morningness, and self-reported time in bed (TIB), sleep latency (SL), total sleep time (TST), and bedtimes and wake times.

Results: PSQI global scores were distributed differently (D = 2.83, p < 0.01) in the athletes (5.0 ± 2.6) compared to the controls (2.6 ± 1.3). For the PSQI component scores, sleep quality (D = 1.63, p = 0.01), sleep latency (D = 1.85, p < 0.01), sleep disturbances (D = 2.02, p < 0.01) and daytime dysfunction (D = 2.92, p < 0.01) were distributed differently, with the athletes reporting greater sleep disturbance and more daytime dysfunction. Morningness scores were also distributed differently (D = 1.45, p = 0.03), with greater skew towards morningness in the athletes. There were no significant distribution differences between the groups for age, gender, TIB, SL, TST, bedtimes and wake times.

Conclusion: Elite athletes reported poorer sleep quality, as evidenced by higher PSQI global scores, and higher PSQI component scores of sleep quality, sleep latency, sleep disturbances, and daytime dysfunction, relative to a control group of healthy, normal sleepers. This was found in the absence of significant group differences in TIB, TST, SE, and timing of the sleep period. However, the athletes' distribution of morningness scores showed greater skew towards morningness. Further research should elucidate whether circadian factors reduce sleep quality in elite athletes and how this impacts on recovery.

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0141

SUSTAINED ATTENTION LAPSES AND BEHAVIOURAL MICROSLEEPS DURING TRACKING, PSYCHOMOTOR VIGILANCE, AND DUAL TASKS

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Introduction: The majority of literature underpinning research into lapses of responsiveness is focused on lapses of sustained attention and comprises two competing theories—the mindlessness and the resource depletion theories. This dichotomy predicts contrasting results with changing task engagement or cognitive workload. Another important lapse is the behavioural microsleep, which is also hypothesized to be dependent on task engagement. This study was undertaken to investigate the propensity for both types of lapse under different levels of task engagement.

Methods: Twenty-three non-sleep-deprived adults (mean age 26.3 years, range 21-40) undertook three counterbalanced tasks that contrasted task engagement and cognitive workload. The 30-min tasks—a psychomotor vigilance task, a continuous tracking task, and both tasks combined to make a more engaging and cognitively-demanding task (dual task)—were completed in a single afternoon session. Reaction times, tracking performance, overt indications of drowsiness, and sleep records were collected.

Results: More sustained attention lapses per participant were seen on the combined task than the PVT task (median 15 vs. 3; range 1-74 vs. 0-76, $p = .001$), with a greater time-on-task effect ($F(5,264) = 4.02$, $p = .002$) evident on the combined task. By contrast, fewer microsleeps (median 0 vs. 0; range 0-1 vs. 0-18, $p = .022$) occurred during the combined task than the tracking task alone. There was a time-on-task effect evident for microsleeps, but only during the tracking task (Chi-squared test(2, $N = 23$) = 6.72, $p = .035$).

Conclusion: The results support the resource depletion theory for attention lapses over the mindlessness theory, with increasing task engagement and cognitive workload and, therefore, resource demand increasing sustained attention lapses over time. Conversely, increasing task engagement almost eliminated microsleeps. Clarifying the relationship between task engagement, cognitive workload, sustained attention lapses, and microsleeps is important if we are to avoid inadvertently increasing these insidious—and potentially fatal—lapses of responsiveness.

0142

ASLEEP AT THE WHEEL: ASSOCIATION BETWEEN DROWSY DRIVING AND OTHER RISK BEHAVIORS AMONG DRIVERS FROM 10 STATES AND PUERTO RICO, 2011

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Introduction: Drowsy driving has been estimated to contribute to up to a third of fatal motor vehicle crashes. However, information on how drowsy driving is associated with other risk behaviors that may also contribute to crash injuries or fatalities is limited.

Methods: Behavioral Risk Factor Surveillance System respondents from 10 states (Alaska, California, Kansas, Maine, Massachusetts, Minnesota, Nebraska, Nevada, Oregon, and Tennessee) and Puerto Rico were asked, "During the past 30 days, have you ever nodded off or fallen asleep, even just for a brief moment, while driving?" Age-adjusted prevalence of drowsy driving (an affirmative response) among 68,665 drivers aged ≥ 18 years by sleep-related and other risk behaviors was determined.

Results: Overall age-adjusted prevalence of drowsy driving in the previous 30 days was 4.0%, ranging from 1.5% in Oregon to 7.6% in Puerto Rico. Respondents who usually slept ≤ 5 hours per 24 hours reported drowsy driving more often than those who slept 6 hours or 7 or more hours (9.0% vs. 5.2% and 2.6%, $p < 0.001$), as did snorers compared to non-snorers (5.6% vs. 2.9%, $p < 0.0001$). In addition, drowsy driving was more prevalent among heavy drinkers than non-heavy drinkers (6.8% vs. 3.8%, $p = 0.011$); among binge drinkers than non-binge drinkers (5.3% vs. 3.6%, $p = 0.003$); and among drivers who sometimes, seldom, or never wear seatbelts while driving or riding in a car compared to those who always or almost always wear seatbelts (6.6% vs. 3.9%, $p = 0.006$). Drowsy driving did not vary by smoking status.

Conclusion: Drowsy driving was associated with excessive alcohol use and not wearing seatbelts, which may further exacerbate the consequences of drowsy driving crashes. Drivers who engage in these risk behaviors may be a good target for drowsy driving education.

0143

THE EFFECT OF LONG-DURATION, MULTI-SEGMENT FLIGHTS ON PILOT SLEEP AND PERFORMANCE

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Introduction: The Island Hopper, a commercial flight operation, originates in Guam, makes three stops in Micronesia, two stops in the Marshall Islands, has a layover in Honolulu, and returns to Guam by the

reverse route. Flown with an augmented crew of three pilots, at any given time in-flight, one of the three pilots is free to rest or sleep. Island Hoppers are not compliant with Federal Aviation Administration (FAA) regulations. Island Hopper flights were compared to other Guam-based flights flown by the same pilots. The other Guam-based flights are compliant with FAA regulations.

Methods: We measured pilot sleep/wake history with the actigraph, predicted effectiveness with the SAFTE/FAST performance prediction model using actigraphically-derived sleep/wake history as input, fatigue with the Samn-Perelli Fatigue Scale, and sleepiness with the Karolinska Sleepiness Scale. We compared flights by operation (Island Hopper vs. non-Island Hopper), flight type (outbound vs. inbound), and flight phase (top of climb vs. top of descent). We used mixed effects analysis of variance to test for differences and the two, one-sided test to test for equivalence.

Results: We found no differences in predicted effectiveness, fatigue, or sleepiness between Island Hopper and non-Island Hopper flights. We found equivalence for predicted effectiveness between Island Hopper and non-Island Hopper flights at top of final descent. We found differences in predicted effectiveness, fatigue, and sleepiness with inbound degraded relative to outbound and top of descent degraded relative to top of climb.

Conclusion: The Island Hopper and non-Island Hopper flights were not different on measures of predicted effectiveness, fatigue, and sleepiness. For predicted effectiveness, Island Hopper and non-Island Hopper flights were equivalent at top of final descent into Guam. On metrics associated with safety, the FAA non-compliant Island Hopper appears equivalent to FAA compliant non-Island Hopper flights.

Support (If Any): The study was supported by United Airlines.

0144

SLEEP QUALITY AMONG POLICE OFFICERS: ASSOCIATIONS WITH OVERTIME AND SECOND JOBS

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Introduction: Sleep quality is an important issue in police work. This study examined cross-sectional associations of two factors that may affect police sleep quality: overtime work and additional employment (second jobs).

Methods: Participants ($n = 402$) were police officers from the Buffalo Cardio-Metabolic Occupational Police Stress Study examined between 2004 and 2009. Officers self-reported overtime work hours during their regular job and hours worked on a second job. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) with higher scores indicating poorer sleep quality. Analysis of covariance was used to examine unadjusted and multivariable-adjusted sleep quality across categories of overtime hours. Trends were tested by fitting linear regression models. Analyses were stratified by hours worked on a second job. Adjustments were made for age, gender, race/ethnicity, and police rank.

Results: In this cohort of officers (mean age = 42 years, SD = 8.1), 74% were male, 78% Caucasian, and 67% patrol officers. There was a significant association between overtime work hours and sleep quality (trend p -value = 0.033). Sleep quality worsened with increasing overtime work hours and the association remained significant after covariate adjustment (trend p -value = 0.009). The association of overtime work hours and sleep quality was dependent on hours worked at the second job (interaction p -value = 0.043). The significant association was evident only among those officers who worked over 10 hours per week at their second job ($n = 63$, adjusted PSQI mean \pm SE global sleep score by

overtime categories: 6.8 ± 0.6 , 6.1 ± 0.9 , and 8.6 ± 0.9 for 0, < 8, and ≥ 8 overtime hours per week, respectively, trend p -value = 0.014).

Conclusion: Overtime work was associated with poor sleep quality, particularly among officers who also worked more than 10 hours per week on a second job. Prospective studies will enhance evidence-based recommendations regarding reasonable levels of overtime and second job work hours that will permit maintenance of good sleep quality.

Support (If Any): National Institute for Occupational Safety and Health contract 200-2003-01580.

0145

GLYCOGEN SYNTHASE KINASE 3-BETA GENOTYPE IS ASSOCIATED WITH SLEEP DURATION IN COLLEGE STUDENTS

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Introduction: Glycogen synthase kinase 3-Beta (GSK3 β) plays a key role in a wide range of cellular processes including phosphorylation and stabilization of a component of the circadian clock, Rev-erb- α . In patients with bipolar disorder, single nucleotide polymorphisms (snps) in GSK3 β have been associated with enhanced antidepressant response to sleep deprivation, earlier age of disease onset, and efficacy of lithium treatment. The aim of this analysis was to explore associations of GSK3 β genotype with sleep duration and mood in college students.

Methods: 680 students (mean age (SD) = 18.6 (0.5) yrs, 59.9% female) completed daily online sleep diaries during the first 8-9 weeks of their first semester at Brown University. We calculated mean total sleep time (TST) across the semester and measured depressive symptoms with the Center for Epidemiologic Studies Depression scale (CES-D) at week 9. Students provided cheek cells for DNA extraction. Genotyping for 8 GSK3 β Tag snps (rs9826659, rs11921360, rs13321783, rs6775397, rs6774210, rs968824, rs11916594, and rs334555) was performed using a Sequenom array. Data were analyzed with PLINK, Haploview, and SPSS.

Results: Average reported TST (SD) was 7.16 (0.67) hrs and average CES-D score (SD) was 14.7 (9.7). Two snps (rs11921360, rs13321783) were not in Hardy-Weinberg equilibrium and one snp (rs968824) had a low genotyping rate of only 64%; therefore, these snps were excluded from further analyses. None of the remaining 5 GSK3 β snps was associated with CES-D score. The snp rs9826659 was associated significantly with diary TST irrespective of mood (β = 0.097, T = 2.104, p = .035). Students with A/A genotype had shorter mean reported TST (SD) across the semester (7.05 (0.66) hrs) than those with the A/G (7.19 (0.67) hrs) or G/G (7.19 (0.63) hrs) genotypes.

Conclusion: In our sample of first-semester college students, the A/A genotype of the GSK3 β snp rs9826659 was associated with shorter reported total sleep time. These data indicate that polymorphisms in circadian clock genes may play a role in sleep length in young adults.

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0146

SLEEP SCHEDULE REGULARITY IN THE TRANSITION FROM HIGH SCHOOL TO COLLEGE

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Introduction: College students are known for having poor sleep and irregular sleep schedules. However, little research has been done examining the changes in sleep schedules from high school to college. We utilize a new questionnaire to examine such changes. We hypothesize that students will transition from a more regular schedule in high school to a less regular one in college and that students with more evening tendencies will have a more irregular sleep schedule.

Methods: Data were obtained from 78 college freshmen (25 males). The Morningness-Eveningness Questionnaire (MEQ) was used to assess morning and evening tendencies. The Sleep Schedule Regularity Questionnaire (SSRQ), created for this study, was used to assess sleep schedules at baseline, during the summer, and during the last semester of high school. Higher scores on the SSRQ subscales indicate a more regular sleep schedule.

Results: The SSRQ had good reliability (α = .83). Morning tendencies were associated with a more regular current sleep schedule (r = .42, p < .001) and a more regular sleep schedule in the last semester of high school (r = .33, p < .001). Students also showed less regular sleep schedules in college than high school (t = 6.1, p < .001) and during the summer than in high school (t = 5.3, p < .001).

Conclusion: Students' sleep schedules become less regular when they transition from high school to college. This may in part be explained by the fact that fewer of them are awakened by a parent or another person in college (n = 19) as compared to high school (n = 33), as well as the fact that they are free to set their own bed times. Additionally, students who have more morning tendencies tend to have a more regular sleep schedule across time, consistent with current literature.

0147

ACTIGRAPHICALLY ESTIMATED SLEEP AND LUX LEVELS IN COLLEGE STUDENTS' LIVING ARRANGEMENTS

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Introduction: Few studies have examined the effects of dormitory living on students' sleep including light levels and technology use (e.g., smart phones, laptops, TVs). Increased exposure to nocturnal light may influence students' sleep. Using actigraphically estimated sleep and lux levels, this preliminary study examined sleep, lux, and technology use for students sharing a bedroom off a hallway vs. students with bedrooms and adjoining common rooms.

Methods: Participants (N = 36 2nd/3rd year) completed the Sleep and Lifestyle in College Dorms Questionnaire and were given two actigraphs (one to estimate sleep patterns; one placed next to sleep area to estimate light throughout night). Participants provided information about living arrangements, electronics and daytime sleepiness, wore an actigraph, and completed a sleep diary for one week.

Results: Although there were no sleep differences for students living with/without a common room, students without a common room reported more tech devices in their bedrooms than students with common rooms (5.5 vs. 4.1, p = .03). Students with fewer than 4 tech devices in their living environment vs. those with 5-12 devices had earlier week-night onset times (12:15 vs. 1:10 am) and longer sleep periods (463 vs. 413 min, p 's < .05). Key associations were found between lux levels, tech devices, and sleep patterns including weekday offset times and lux above 20% during sleep period (r = .38, p = .02) and number of tech devices and lux above 20% (r = .30, p = .05).

Conclusion: Preliminary findings suggest that although the structure of college dorms may not lead to healthy vs. unhealthy sleep patterns, clearly more tech devices and associated lux levels might lead to more delayed and less weeknight sleep for college students. Additional participants and analyses will help to understand the impact of living arrangements, technology use, and lux levels for emerging adults.

Support (If Any): College of the Holy Cross Student Grant.

0148

THE RELATIONSHIP BETWEEN TELEVISION VIEWING AND SLEEP DURATION

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Introduction: Television viewing has been associated with both short and long sleep duration. The relationship between television viewing and habitual sleep duration is complex and likely depends on sociodemographic characteristics as well as the time-of-day and duration of television viewing.

Methods: Analyses are based on a representative sample of Americans 15 years and older participating in the 2003-2011 American Time Use Surveys (N = 124,517).

Results: When adjusting for age, gender and race, long sleepers (≥ 11 h/night) spent more time watching television compared to average (> 6 h and < 11 h) and short (≤ 6 h/night) sleepers. When examining time-of-day, long sleepers spent more time watching television during daytime hours (i.e., 1000-1900 h). Although short and average sleepers did not differ in terms of time spent watching television in a 24 h period, short sleepers spent more time watching television during late-night/early-morning hours (i.e., 2200-0530 h) compared to average sleepers. When adjusting for a host of demographic variables we found that individuals who were not currently working (i.e., absent from work, unemployed, retired, or not in the labor force) were at increased odds for being a long sleeper.

Conclusion: Consistent with previous studies, although short sleepers do not watch more television in a given 24 h period, these individuals do watch more television during late-night/early-morning hours. Reducing time spent watching television during this time may lead to longer sleep duration and a reduction in sleep debt. The relationship between long sleep duration and greater television viewing does not suggest that viewing more television will lead to more sleep. Rather it is likely that long sleepers have more discretionary time and spend that time viewing television and sleeping. Indeed, additional time spent viewing television occurred during daytime hours and individuals not in the work force were more likely to be long sleepers.

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0149

IMPACT OF DORM ENVIRONMENT ON CAFFEINE CONSUMPTION, TECHNOLOGY USE AND SLEEP IN COLLEGE STUDENTS

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Introduction: Research indicates that caffeine and technology use before bedtime results in delayed sleep onset, less sleep, and more sleep disturbances. Caffeine may play a significant role in social gatherings. College students' lifestyles and living arrangements might contribute to sleep patterns, caffeine, and technology use. This study examined how dorm environments (common room vs. bedroom without shared space) contribute to sleep patterns, caffeine consumption, and technology use in students.

Methods: College students (N = 54 2nd & 3rd year) completed Sleep and Lifestyle in College Dorms Questionnaire to assess living arrangements, sleep patterns, caffeine and technology use, sleepiness, and sleep/wake behavior problems. Variables included sleepiness, sleep-wake behavior problems, caffeine intake and frequency in past 2 weeks.

Results: Students living with common rooms reported more overall tech devices than peers without a common room; however, they had fewer devices in their bedrooms (total devices: 6.0 vs. 4.9; bedroom: 3.7 vs. 4.9). Likewise, they had later rise times on weekdays/ends vs. peers with shared bedrooms off a hallway (p 's $< .05$). Interestingly, students living with a common room reported more frequent and higher daily caffeine intake versus peers without a common room (p 's $< .001$; 51.2 oz vs. 23.3 oz). Correlations revealed significant associations (p 's $< .05$): caffeine intake and sleepiness = .38; caffeine frequency and bedtime = .32; tech devices and rise time = .29.

Conclusion: Similar to previous studies, higher caffeine consumption and technology use was associated with more delayed sleep, sleepiness, and sleep problems in emerging adults. New findings suggest that college students' living arrangements play a role in sleep patterns, caffeine consumption, and technology use. Although common rooms allow students to keep light emitting technology out of bedrooms, similar devices (i.e., smart phones, laptops) along with socializing connected to a common room may contribute to increased caffeine consumption and altered sleep patterns.

Support (If Any): College of the Holy Cross Student Grant.

0150

THE ASSOCIATION BETWEEN CAFFEINE CONSUMPTION AND OBJECTIVE MEASURES OF SLEEP IN SCHOOL-AGE CHILDREN

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Introduction: Habitual daily caffeine consumption has been related to sleep disruption, and an inverse relationship has been observed between caffeine consumption and sleep times. Despite the widespread and increasing consumption of caffeine by children and the negative impact of caffeine on sleep, there has been little research on the relationship between caffeine and sleep in a pediatric population, with no information available on the association between caffeine intake and objective measures of sleep. This study was designed to examine the association between caffeine consumption and objective measures of sleep in school-age children.

Methods: In preparation for designing a school-based intervention for the prevention of childhood obesity, we measured sleep and nutritional habits of elementary school students. Sleep was measured for 5 consecutive school-nights using actigraphic recording (AW-64 series, Mini-Mitter); caffeine intake was measured using the Food Frequency Questionnaire (FFQ), an online questionnaire that asks respondents to report the frequency and quantity of food consumption over the previous month.

Results: In the children studied, sleep duration gradually decreased with age [$F(2,47) = 7.73, p < 0.001$]. Caffeine consumption gradually increased with age although differences were not statistically significant. Partial correlation analyses, corrected for age, indicated that sleep duration was negatively correlated with caffeine intake ($r = -0.37^*, p < 0.05$), with shorter sleep duration associated with greater caffeine consumption.

Conclusion: Caffeine consumption was associated with shorter sleep duration measured objectively in children aged 6 to 12 years. Due to the negative impact of short sleep duration on children's academic performance and behavior, caregivers should be made more aware of the impact of even small amounts of caffeine on the sleep of school-age children. Future research should explore how caffeine consumption can be effectively reduced in this population.

Support (If Any): American Sleep Medicine Foundation.

0151

COLLEGE STUDENTS SEEKING SLEEP INSTRUCTION TO IMPROVE THEIR OWN SLEEP

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Introduction: That college students experience inadequate and often disrupted sleep is well-founded. These sleep problems result in academic difficulties and accident proneness, among other problems. Any instruction on sleep in undergraduate courses is often cursory, at best, leaving most students uninformed about normative and non-normative sleep, good sleep habits, or real-life implications of inadequate or problematic sleep. The current study aims to investigate how students who choose to take a sleep course differ from those who do not over time.

Methods: Forty-seven first semester college freshmen completed a battery of sleep surveys including the Pittsburgh Sleep Quality Index (PSQI) approximately every four weeks during the course of a 15-week semester. Twenty of these students were enrolled in a sleep-specific seminar course in which they were placed based on interest. Twenty-seven control participants were enrolled in Introduction to Psychology courses.

Results: Repeated-measures ANOVAs using Wilks' Lambda test statistic were run examining change in PSQI subscales over time for both the sleep course and control participants. The groups differed on sleep efficiency (SE) [$F(2,44) = 3.82, p = .03$], with sleep course participants demonstrating poor SE at Time1 and improving over time and control participants demonstrating good SE at Time1 and decreasing over time. The groups also differed on daytime dysfunction (DD) [$F(2,44) = 4.18, p = .02$] with sleep course participants reporting more DD than control participants over time and improvement in DD.

Conclusion: Students enrolled in a sleep-specific course demonstrated poorer SE and DD at the beginning of the study than a control group, and the sleep-specific group also improved on these measures over time. It seems that college students with sleep problems self-selected into a course sleep-specific course whose instruction was effective in improving these measures of sleep quality. These findings suggest the importance in providing sleep-specific instruction to all college students and specifically those reporting sleep problems.

0152

BIAS OF REPORTING SLEEP PROBLEMS AMONG BLACKS

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Introduction: Sleep disturbance is a common complaint in the general population. Studies have shown that there are substantial differences between and within racial/ethnic groups with respect to reporting sleep problems, with blacks being less likely to report such problems. Previous studies, however, have not specifically examined black patients with symptoms of obstructive sleep apnea (OSA). This study sought to investigate further whether blacks at risk for OSA are likely to report sleep problems, which would suggest no bias in reporting.

Methods: We analyzed data from the Metabolic Syndrome Outcome (MetSO) study, an NIH-funded cohort study of 1,035 blacks (mean age: 62.3 ± 13.5 years, women = 69%) with metabolic syndrome. Metabolic syndrome was diagnosed using criteria articulated in the joint interim statement for harmonizing the metabolic syndrome. Patients with a score ≥ 6 on the Apnea Risk Evaluation System (ARES) were considered at high OSA risk. To assess sleep habits and problems, we administered the Sleep Disorders Screening questionnaire. The data was coded and analyzed using SPSS 19.0.

Results: Of the sample, 60.4% had diabetes; 92.3%, hypertension; 74%, dyslipidemia; and 66.9%, obesity. Overall, 48.9% of the patients were at high OSA risk. Patients at OSA risk were more likely to report having trouble falling asleep (58.3% vs. 43.7%, $p < 0.001$), trouble staying asleep (60.5% vs. 41.2%, $p < 0.001$), complaint of early morning awakenings (58.4% vs. 42.2%, $p < 0.001$), daytime naps (53.4% vs. 44.4%, $p < 0.001$), excessive daytime sleepiness (56.8% vs. 40.2%, $p < 0.001$), and being diagnosed with insomnia (63.7% vs. 47.9%, $p < 0.001$).

Conclusion: Nearly half of the blacks with metabolic syndrome were at risk for OSA. Those at OSA risk were more likely to report sleep problems. Compared with previous studies, our analysis does not show a reporting bias among blacks, at least among those at risk for OSA.

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0153

DO ATTITUDES MATTER? EXAMINING ATTITUDES TOWARDS SLEEP IN COLLEGE STUDENTS

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Introduction: Emerging adults, particularly college students, are a top at-risk group for sleep loss and poor sleep quality. Considering the deleterious effects of poor sleep on health and well-being, research identifying factors that hinder sleep among college students is relevant. Poor sleep hygiene behaviors have been shown to contribute to inadequate sleep. Furthermore, cognitive factors including attitudes and knowledge have been identified as key predictors of other health behaviors such as exercising and wearing sunscreen, therefore the present study examines associations between sleep attitudes, knowledge, and sleep behaviors. The present study hypothesizes that sleep attitudes and knowledge will predict sleep behaviors, which will in turn serve as significant predictors of sleep outcomes.

Methods: Ninety-four college students (70% female) self-reported demographic information, sleep behaviors, depression, sleep attitudes and

sleep knowledge. Sleep duration, sleep quality and global sleep scores were measured via the Pittsburgh Sleep Quality Index.

Results: Knowledge was significantly associated only with attitudes ($r = .36, p < .001$), while attitudes were associated with arousal-related sleep hygiene behaviors ($r = .24, p < .05$), sleep duration ($r = .33, p < .005$), and global sleep scores ($r = .25, p < .05$). After controlling for age and gender in path analysis, negative attitudes directly predicted arousal-related behaviors ($b = .12, p < .05$) and sleep duration ($b = -.03, p < .005$) and yielded significant indirect effects on sleep quality ($b = .01, CI [.001, .01]$) and global sleep scores ($b = .06, CI [.004, .05]$). However, after depression was entered into the model, sleep attitudes no longer emerged as a significant predictor.

Conclusion: Findings suggest attitudes may be more important than knowledge-based influences on sleep and sleep hygiene among college students. Depression emerged as a salient factor and should be considered in future research and application efforts related to attitudinal and behavioral contributors to sleep outcomes in college samples.

0154

DIFFERENCES IN ANTICIPATED VERSUS EXPERIENCED COLLEGE SLEEP PATTERNS

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Introduction: The transition from high school to college can be a stressful time for young adults and is associated with changes in reported sleep patterns. This analysis examines the differences between anticipated and diary-reported college sleep.

Methods: Participants were first year college students at Brown University in 2010-2012 ($N = 361$; mean age = 18.7, $SD = 0.4$; 58% female). In the summer before matriculation, participants completed a survey from Brown's residential life office asking their "anticipated" bedtimes and rise times with multiple choice responses. For rise times: a) before 7 am; b) 7-8 am; c) 8-9 am; d) 9-10 am; e) after 10 am. For bedtimes: a) before 11 pm; b) 11 pm-12 am; c) 12-1 am; d) 1-2 am; e) after 2 am. Responses were coded as midpoint of the range for b, c, and d, and as .5 hours earlier or later for a and e, respectively. Participants completed > 50% of daily sleep diaries online for 8-9 weeks and the STAI anxiety scale and CES-D depression scale at the end. Diary average bedtimes and rise times were computed. Repeated measures ANOVA examined differences between anticipated and diary-reported college sleep. Anticipated and diary-reported difference scores for bedtime and rise time were added to create a total difference score (TDS) for each student. Linear regression was used to assess TDS as a predictor of STAI-state and CES-D in two separate models.

Results: Diary-reported bedtimes and rise times were significantly later than anticipated bedtimes ($F[1, 344] = 580.3, p < .001$) and rise times ($F[1, 349] = 82.1, p < .001$). Anticipated bedtime: $M = 12:12$ am, $SD = 0.8$ h; Diary-reported bedtime: $M = 1:24$ am, $SD = 1.0$ h. Anticipated wake time: $M = 8:12$ am, $SD = 0.9$ h; Diary-reported wake time: $M = 8:42$ am, $SD = 0.9$ h. TDS was not significantly associated with either STAI-state ($R = 0.1, p = 0.1$) or CES-D ($R = 0.02, p = 0.8$).

Conclusion: Bedtimes and rise times of students were significantly later than they anticipated. Differences between anticipated and experienced sleep patterns were not associated with anxiety or depression.

Support (If Any): This work was supported by the National Institute for Mental Health (Grant R01 MH079179).

0155

SEX DIFFERENCES IN SENSITIVITY TO THE TIMING AND REGULARITY OF SLEEP-WAKE BEHAVIORS

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Introduction: Sex differences in core body temperature and melatonin secretion patterns indicate that women may favor earlier sleep-wake times. Animal models suggest sleep in females may be more sensitive to inconsistent sleep-wake routines. Therefore, sex may moderate relationships between sleep-wake timing and indices of sleep. We assessed habitual sleep-wake times and intra-individual variability in sleep-wake timing, asking whether relationships to objectively measured sleep and the Pittsburgh Sleep Quality Index (PSQI) differed by sex.

Methods: Participants included 26 men and 18 women without a history of depression. Participants recorded sleep and wake times for 7-14 days (mean 9.73 ± 1.77). All participants completed two nights of laboratory polysomnography (PSG) and PSQI. Adjusting for age, hierarchical multiple regressions assessed whether sex moderated relationships between PSG and PSQI measured sleep and both means and standard deviations of diary-based sleep-wake times.

Results: In women, later wake-up time was associated with longer sleep latency ($\beta = .454, p = .027$) and greater wakefulness after sleep onset (WASO; $\beta = .420, p = .033$). Variability in wake-up time was also associated with longer sleep latency in women ($\beta = .456, p = .017$). Later bed time was associated with higher PSQI scores in men only ($\beta = -.510, p = .007$). Greater variability in bed time was associated with higher PSQI scores ($\beta = .392, p = .025$), greater WASO ($\beta = .386, p = .017$), and less sleep efficiency ($\beta = -.335, p = .035$) in women only.

Conclusion: Wake-up time and variability in sleep-wake times were closely related to sleep in women but not in men, supporting the hypothesis that women may be more sensitive to timing and inconsistencies in sleep-wake routines. Conversely, later bed time was associated with poor sleep quality in men but not women. The current study is limited by a small sample size but provides preliminary support for sex differences in relationships between sleep-wake timing and indices of sleep.

Support (If Any): NIH grants T32 HL007560-29, R01 HL104607, and UL1 TR000005.

0156

MALADAPTIVE SLEEP BELIEFS AND SLEEP HYGIENE ARE BETTER PREDICTORS OF INSOMNIA THAN PERSONALITY

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Introduction: Insomnia is a risk factor for many health conditions, including cardiac problems. University students are at increased risk of insomnia due to erratic sleep schedules and poor sleep hygiene. While Type D personality has also been associated with cardiovascular disease (CVD), there are currently no studies examining its relationship with sleep difficulties in healthy adults. The present study investigated the association of Type D personality with insomnia severity, and whether this relationship was mediated by known sleep-interfering factors, namely sleep hygiene and maladaptive sleep beliefs.

Methods: 336 university students ($M = 107, F = 229$) aged between 18 and 25 (mean = 20.18 years, $SD = 1.97$) completed an online questionnaire comprising of the DS-14, the Insomnia Severity Index (ISI), the Dysfunctional Beliefs and Attitudes about Sleep scale (DBAS-16), and the Sleep Hygiene Index (SHI).

Results: 32.8% of students reported symptoms indicating sub-threshold insomnia, with 11.3% evidencing moderate to severe clinical insomnia.

Type D personality students experienced more sleep disturbances ($r = 0.276$, $p < .005$), reported poorer sleep hygiene practices ($r = -0.263$, $p < .005$) and endorsed more maladaptive beliefs about sleep ($r = 0.338$, $p < .0005$). However, in a hierarchical regression dysfunctional sleep beliefs and sleep hygiene were independent predictors ($p < .005$) of insomnia severity, accounting for 35.5% of the variance, while Type D personality failed to contribute to the model.

Conclusion: The relationship between personality and insomnia is primarily explained by maladaptive sleep beliefs and sleep hygiene practices. These modifiable variables may be targeted by a tailored cognitive-behavioural intervention to enable students to improve their sleep, and possibly mitigate future cardiac risk.

0157

UNDERSTANDING PERCEPTIONS OF GOOD AND BAD SLEEP

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Introduction: Tracking health risk behaviors in the general public is the objective of the Center for Disease Control (CDC) telephone survey Behavioral Risk Factor Surveillance System (BRFSS). Sleep behavior questions were added to identify sleep/wake disorders that affect health but were never validated. The objective of this study was to establish succinct, valid and reliable questions to predict and detect sleep/wake disorders. This paper reports on findings of the Phase II qualitative interviews of 30 subjects randomly obtained from within the larger Phase I sample ($N = 300$). The objective of this phase of the study was to obtain narrative descriptions of good or bad sleep and eventually explore subjective congruence with Phase I responses.

Methods: Thirty subjects were recruited in 6 small groups (per actigraphy sleep hours) to include 10 good sleepers (6-8 hours), 10 short sleepers (< 6 hours), and 10 long sleepers (> 8 hours), in each group, 5 agreed and 5 did not agree with their self-reports. The interviewer, blinded as to their ratings, asked them to describe a typical good and bad night sleep, and what contributed to their sleep. Subjects were asked to discuss the ease or difficulty in answering the BRFSS questions. Interviews were audio taped and transcribed for thematic descriptions of good and bad sleep, blinded to the grouping.

Results: Good sleep was obtaining uninterrupted sleep to awake refreshed, energized and in a good mood. Contributing factors included the sleep environment and caffeine intake. Poor sleep was having difficulty falling asleep due to unresolved worry or environmental interruptions, frequent waking and trouble falling back to sleep, having difficulties getting through the day because of inability to focus and the desire to go to back to sleep.

Conclusion: Preliminary analysis revealed that perceived outcomes of poor sleep may be a universal way to detect sleep/wake disorders.

Support (If Any): This abstract is a product of the Rochester Prevention Research Center: National Center for Deaf Health Research and was supported by Cooperative Agreement Number U48DP001910 from the CDC. The findings and conclusions in this abstract are those of the author(s) and do not necessarily represent the official position of the CDC.

0158

WHAT ARE POSTPARTUM WOMEN DOING WHILE THE REST OF THE WORLD IS ASLEEP?

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Introduction: Postpartum sleep is characterized by marked fragmentation. Yet there are large individual differences in women's resulting

daytime dysfunction and mental health impairment. Our goal was to explore aspects of women's nocturnal environment and behaviors that may explain differences in postpartum adjustment.

Methods: 201 mothers (27.8 [SD \pm 4.8] years, 83.1% white, \$69,000 [SD \pm \$43,000] household income) of infants 0-6 months completed an online survey with demographics, number and duration of nocturnal awakenings, caretaking behaviors, environment, and nocturnal activities during: "One typical night during the past week."

Results: Mothers reported 2.9 (SD \pm 1.6) awakenings, each lasting 33.9 (SD \pm 22.5) minutes. Infant age was inversely related to duration ($p < .001$) but unrelated to number of awakenings. Bed-sharing mothers reported more awakenings ($p = .001$) of shorter duration ($p < .001$) than non-bed-sharers (breastfeeding, reported by 94.2% of bed-sharers [$p < .001$], showed the same result). Falling asleep while feeding was less frequent among exclusively formula-feeders ($p = .003$). Among the entire sample, mothers used a cell phone (59%), backlit tablet (25%), TV (20%), and computer (16%) during nocturnal awakenings. Watching TV ($p = .011$) and using a computer ($p = .019$) were each associated with longer nocturnal awakenings. 89% of women used ≥ 1 extra light source during nocturnal awakenings: night light (35%), light from a cracked door (28%), desk lamp (25%), electronic device (19%), or room light (14%). Light source(s) was unrelated to number or duration of nocturnal awakenings.

Conclusion: These data suggest that bed-sharing and breastfeeding mothers awaken more often at night, albeit for shorter durations. Although supplemental light was unassociated with awakenings, TV and computer use accounted for longer awakenings. Sleeping location, feeding method and technology use may help explain individual differences in postpartum adjustment and may be targets for more effective interventions to improve maternal postpartum sleep and daytime functioning.

0159

THE ASSOCIATION BETWEEN SLEEP DURATION AND PSYCHOLOGICAL ADJUSTMENT TO DIVORCE IS MODERATED BY NUMBER OF CHILDREN

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Introduction: Half of all marriages in the US end in divorce, and recovery from divorce varies significantly between individuals. The extent to which sleep or having multiple children is associated with recovery from divorce is currently unknown. The goal of the present study was to examine the association in divorcing parents between number of children, sleep problems, and psychological adjustment to divorce over time.

Methods: 43 parents (25 females) who had physically separated from their ex-partner in the past five months completed measures at five monthly time points. Psychological adjustment to the separation was operationalized using the Impact of Events Scale-Revised (IES-R), which was completed along with a week-long sleep diary at monthly intervals. Multilevel modeling was used to test the association between number of children (single versus multiple), average self-reported nightly total sleep time (TST), and time since separation on IES-R after controlling for relationship length.

Results: The interaction between number of children, TST, and time since separation was significant, $F(1, 147) = 7.60$, $p < 0.01$. Parents with only one child showed a negative association between TST and IES-R that decreased in magnitude over time ($b = -0.07$ at baseline, $b = -0.03$ at ten months post-separation). Parents with multiple children, however, showed an association between TST and IES-R that was positive at the time of separation ($b = 0.14$), and then became negative at ten months post-separation ($b = -0.06$).

Conclusion: There was an association between sleep and divorce recovery in parents with one child, such that decreased sleep was associated with greater distress, and that this association became weaker over time. Parents with multiple children, however, showed an association that was in the opposite direction at time of separation, but which reversed by ten months post-separation to become consistent with parents with one child.

Support (If Any): The data for this project was collected under HD069498 (RB).

0160

THE IMPACT OF COPING STYLES ON SLEEP IN DIVORCING INDIVIDUALS

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Introduction: Poor coping styles have been linked to poorer sleep and sleep problems in individuals diagnosed with severe illness. Similar to being diagnosed with a severe illness, divorce is associated with many stressors. The goal of the present study is to examine the impact of coping styles on sleep in participants going through marital separation, hypothesizing that positive coping styles will predict better sleep and negative coping styles will predict poorer sleep.

Methods: 76 individuals (53 females) who had physically separated from their ex-partner within five months of joining the study completed the brief COPE which measures coping styles, and sleep diaries. Regression analyses were used to examine coping styles as predictors of sleep.

Results: Specific self-reported coping styles were predictive of poorer sleep quality as reported by sleep diaries in divorcing individuals. Participant's self-reported use of emotional support as a coping mechanism predicted higher sleep efficiency ($\beta = .50, p < .05$) and total sleep time ($\beta = .47, p < .05$). The use of humor as a coping mechanism was also predictive of fewer awakenings ($\beta = -.52, p < .05$), use of active coping predicted more wake after sleep onset ($\beta = 2.03, p < .05$), positive framing predicted less wake after sleep onset ($\beta = -2.24, p < .05$), and use of emotional support predicted less sleep onset latency ($\beta = -2.70, p < .05$).

Conclusion: Currently, there are contradictory theories about whether positive or negative coping styles have the greatest impact on sleep. This study shows that sleep in divorcing individuals may be positively impacted by practicing positive coping styles such as emotional support and humor. Increased use positive coping styles were more predictive of sleep than negative coping styles, which suggests that positive coping styles may buffer negative sleep outcomes stemming from stressors.

Support (If Any): The data for this project was collected under HD069498 (RB).

0161

IMPACT OF PEER HABITS AND SLEEP PROBLEMS ON DRUG USE

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Introduction: Previous research has shown that insufficient sleep and peer use of illicit drugs have a negative linear effect on adolescents' substance abuse. Sleep times ≤ 7 hours and peer use have been associated with marijuana use. The current study aims to examine the link between nightmares/trouble sleeping and peer use of illicit drugs among adolescents referred to a county court for behavioral or legal problems. We hypothesized peer use of illicit drugs and participant report of nightmares and trouble sleeping would both be related to reports of frequent drug use.

Methods: Participants included 66 adolescents aged 14-18. Data was from a secondary data source. The questions "Have you had nightmares/

trouble sleeping in the past year" (yes/no) and "Have your peers used drugs in the past 90 days" (yes/no), were treated as independent variables and a scale measuring substance problems in the last month as the dependent variable. Data was analyzed using an ANOVA and Bonferroni post hoc test.

Results: Participants reporting trouble sleeping and nightmares were more likely than those without sleeping difficulty to have a substance problem during the last 30 days ($M = 4.13, SD = .51$) [$F(1,62) = 12.58, p < 0.05, d = 1.25$]. Peer use was also independently related to higher levels of substance problems ($M = 4.44, SD = .56$) [$F(1,62) = 19.28, p < 0.05, d = 1.32$]. Moreover, an interaction was found between peer use and trouble sleeping/nightmares, showing that those with sleep issues and with peers who used illicit drugs were more likely to have a substance problem in the last month ($M = 6.69, SD = .72$) [$F(1,62) = 6.77, p < 0.05, d = 1.65$].

Conclusion: Adolescents with sleeping difficulty as well as peers who used drugs independently influence substance problems, though peer influence on drug use is well researched. The current results suggest the importance of monitoring sleep troubles, particularly among at-risk youth, as this might be an indicator of or impetus for drug use or relapse.

Support (If Any): Robert Wood Johnson Reclaiming Futures Fund.

0162

ADOLESCENT SUBSTANCE USE AS A SLEEP AID LINKED TO POOR MENTAL HEALTH

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Introduction: The link between sleep and mood disorders is well established. Moreover, substance abuse has been associated with both poor sleep and depression. In a normative population of high school students it has been found that few hours of sleep is associated with increased depressive symptoms and that sleep problems are associated with substance use (tobacco, alcohol, marijuana, and other illegal drugs). The current study aims to investigate the link between the use of alcohol or drugs as a sleep aid with depressive symptomatology, internalizing, and emotional problems among a population of at-risk adolescents.

Methods: Secondary analyses were done using a database of adolescents ($n = 66$), aged 12-18, who were referred to a juvenile court for legal and/or behavioral problems. All reports were collected at intake by a trained interviewer. A multivariate analysis of variance (MANOVA) using Wilks' Lambda with followup univariate tests were used to investigate whether participants who reported using alcohol or drugs to help them sleep (yes/no) differed on their report of emotional problems (Emotional Problems Scale), internal mental distress (Internal Mental Distress Scale), or depressive symptomatology (Global Appraisal of Individual Needs).

Results: The omnibus MANOVA was significant $F(3,62) = 9.36, p = .001$. Use of drugs or alcohol to sleep was significantly related to more emotional problems $F(1,64) = 13.76, p = .001, d = 1.15$, more internal mental distress $F(1,64) = 27.01, p = .001, d = 1.48$, and more depressive symptoms $F(1,64) = 7.37, p = .009, d = 0.84$.

Conclusion: Adolescents using alcohol or drugs as a sleep aid are at risk for emotional problems, internal mental distress, and depressive symptoms. Though the causality of these variables is unclear, the current study suggests that adolescents, particularly those engaging in potentially illegal behaviors, might benefit from a multi-pronged treatment plan including mental health services and sleep education or training.

Support (If Any): Robert Wood Johnson Foundation Reclaiming Futures Fund.

0163

**“I PUT THE MACHINE ON AND I SLEEP LIKE A BABY...”
A CULTURALLY AND LINGUISTICALLY TAILORED
TELEPHONE-BEHAVIORAL INTERVENTION TO INCREASE
ADHERENCE TO SLEEP APNEA RECOMMENDATIONS
AMONG BLACKS WITH METABOLIC SYNDROME**

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Introduction: Blacks are less likely to adhere to sleep apnea treatment compared with whites. This study explored the unique perspectives of blacks with metabolic syndrome who were referred for treatment of obstructive sleep apnea (OSA) at local sleep clinics.

Methods: A total of 340 adults from the Metabolic Syndrome Outcome Study (MetSO), an NIH-funded cohort study of blacks, were randomly assigned to receive either Tailored-Telephone Intervention or regular standard of care. Prior to randomization, participants provided a detailed sleep history assessing sleep habits and OSA risk. The qualitative study involved 4 focus groups (mean age = years; 4 Males, 22 Females). A focus group guide was used to elicit responses from participants. Interviews were audio-taped and transcribed verbatim. Initial a priori codes were developed to guide initial coding. Analysis was guided by grounded theory. We explored 3 important questions: Q1) What are the potential barriers and facilitators of OSA evaluation? Q2) What are the potential barriers and facilitators of CPAP adherence? Q3) What are the experiences of blacks who participated in the intervention?

Results: Themes for each question were as follows: Q1 a) general sleep disturbances, b) presence of other health conditions, c) encouragement from loved ones and d) rapport with medical provider plays a key role in adhering to OSA evaluation. Q2 a) improvement in sleep apnea, b) CPAP side effects, c) mistrust of the medical system, d) socio-economic factors limiting ability to participate and e) perception that CPAP device is not necessary were barriers and facilitators of CPAP adherence. Q3 a) having received meaningful information about sleep disorders, sleep hygiene b) increase in health information and c) rapport with the health educator were the experiences of participants in the intervention.

Conclusion: To our knowledge, this is the first study to describe qualitative findings of blacks with metabolic syndrome that participated in an OSA-related intervention. Behavioral health interventions that are culturally tailored for minority populations can be effective in increasing adherence to physician-recommended OSA screening procedures.

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0164

THE ASSOCIATION OF CIRCADIAN RHYTHM AND SLEEP WITH COGNITIVE FUNCTIONING: A POPULATION-BASED STUDY

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Introduction: Cognitive functioning changes with age, sleep and the circadian rhythm. We tested if the circadian rhythm and sleep are independently associated with different cognitive domains in middle-aged and elderly persons.

Methods: We collected actigraphy recordings of at least 92 hours (138 ± 14 hours, mean \pm standard deviation) in 1734 middle-aged and elderly participants (age 62 ± 9.4 years) of the Rotterdam Study. Actigraphy was used to quantify diurnal rhythms by calculating the stability of the rhythm over days and the fragmentation of the rhythm. The sleep parameters total sleep time, sleep onset latency and wake after sleep onset were also determined by actigraphy. Sleep quality was determined with a sleep diary during the week of actigraphy. Cognitive functioning was assessed with a test-battery including the Word Learning Test (WLT), Word Fluency Test (WFT), Letter Digit Substitution Task (LDST) and Stroop Color Word Test (Stroop). We used linear regression analyses adjusted for sex, age, employment status, education, body mass index, smoking, depressive symptoms, health status, myocardial infarction, stroke, diabetes mellitus, possible apnea and time of testing.

Results: Persons with less stable circadian rhythms performed worse on the LDST ($B = 0.48$, $p = 0.001$) and needed more time on the Stroop interference trial ($B = -1.42$, $p < 0.001$). Similarly, persons with more fragmented rhythms performed worse on the LDST ($B = -0.53$, $p = 0.001$) and the Stroop ($B = 1.67$, $p < 0.001$). In contrast, longer observed sleep onset latencies were only related to less words on the WLT delayed recall ($B = -0.019$, $p = 0.027$) and the WFT ($B = -0.46$, $p = 0.007$). Perceived sleep quality, as rated by the participant, was not related to cognitive functioning.

Conclusion: Circadian and sleep disturbances were independently related to cognition; while persons with longer sleep onset latencies had worse memory, persons with circadian disturbances performed less on executive functioning and perceptual speed tasks.

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0165

SLEEP SPINDLES, RESTING-STATE FUNCTIONAL CONNECTIVITY AND EXECUTIVE FUNCTIONING IN YOUNGER AND OLDER ADULTS

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Introduction: Sleep spindles are positively correlated with executive functioning. Additionally, functional connectivity within the default mode network, a system engaged during passive waking, is predictive of better executive functioning. Both of these factors are altered in normal aging, but it is unclear whether they are interdependent.

Methods: To examine the relationship between functional connectivity, sleep spindles, and executive functioning, we used resting state fMRI,

neuropsychological testing, and nap polysomnography in younger ($n = 12$; age 21-29) and older adults ($n = 7$; age 62-74). Two subtests of the Delis Kaplan Executive Function System (Trails and Stroop) were used to obtain a composite executive function score.

Results: As expected, older adults scored significantly worse on this composite measure of executive function ($t(18) = 2.56$; $p = .019$). Moreover, sleep spindle density in the central EEG band across a nap was positively correlated to executive functioning in older adults ($r = .701$; $p = .036$). Executive functioning was significantly predicted by co-activation between the thalamus and the inferior frontal gyrus (R -squared = .594; $p = .036$), and also by central band spindle density (R -squared = .418; $p = .026$). A mediation analysis showed that the relationship between executive functioning and spindle density was mediated by thalamo-frontal connectivity; the regression coefficient for the association between the spindles and executive functioning decreased from 9.13 to -2.19 when controlling for connectivity, and the regression model became non-significant, $p = 0.84$. No associations were present between connectivity, spindles, and executive function in the younger adult group.

Conclusion: As structural integrity may underlie both spindle activity and functional connectivity, this may be a mechanism for the strengthened relationship between these two components. Future analyses will include investigation of additional resting-state functional networks and quantification of overnight sleep.

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0166

INDIVIDUAL DIFFERENCES IN SLEEP-RELATED BENEFITS FOR CREATIVE INSIGHT

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Introduction: Exposure to elements of a problem benefits insight, and sleep enhances integration of unassociated information for creative problem solving (Cai et al. 2009). Here, we examined individual differences in the role of sleep for insight.

Methods: During session 1, 24 (17F) young, healthy subjects completed 10 items from the Remote Associates Test (RAT) followed by 30 analogies. 10 of the analogy answers were primes for future RAT items. At 1:30 PM, subjects took a 90 min polysomnographically-recorded nap. During session 2, subjects completed 30 RAT items: 10 old (same items as session 1), 10 primed (answers primed by analogies), and 10 novel. We calculated regression residuals to indicate which subjects showed improvement for old items above and beyond what was predicted by their AM performance (HIGH), and which subjects performed worse than predicted (LOW).

Results: There was no baseline difference between HIGH and LOW groups. Following sleep, the HIGH group showed benefits for old ($p < .001$) and primed ($p = .02$) items, and no improvement for novel items, compared to baseline. The LOW group showed no sleep benefits. Between-group comparisons found that the HIGH group outperformed the LOW group on old ($p = .01$) and primed items ($p = .004$). The groups did not differ on novel items. For subjects who benefitted from sleep (HIGH), the degree of improvement was associated with sleep features: spindle density for old items ($r = .60$, frontal) and slow wave activity (SWA) for primed items ($r = .72$, frontal; also significant at central and parietal sites).

Conclusion: Replicating our prior findings, sleep benefited the creation of new associations between unrelated elements that had been previously exposed, but not for all individuals. For people who showed sleep-related enhancement, our data indicate that sleep features may facilitate problem solving in two distinct ways: spindles may enhance incubation via replay of the original problem, whereas SWA may benefit the semantic representation of primed answers.

0167

SLEEP FACILITATES MEMORY BY PROVIDING 'TEMPORAL SCAFFOLDING' OF EXPERIENCE: A NETWORK MODEL*Lerner I, Gluck MA*

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Introduction: Neural firing patterns occurring in the hippocampus at wake are reactivated in a time-compressed manner during Sharp-wave-ripple episodes at Slow-Wave-Sleep (SWS). These “replays” have been shown to improve performance in memory-related tasks, hypothetically by supporting memory consolidation: a process by which hippocampal memory traces are transformed to the neocortex for long-term storage. However, the way replays, a neuronal-scale phenomenon investigated primarily in rats, is related to findings concerning sleep-improved memory functions in humans, is yet unknown. In the current work, we attempt to bridge this gap by presenting a computational model that uses compressed replays to extract temporal structures in hippocampally-encoded memory sequences.

Methods: We built a neural network model of the Entorhinal-cortex (EC) that received hippocampal/cortical inputs and employed Hebbian-learning. The network could run in two modes: ‘wake’, during which it received trial-by-trial cortical inputs, mimicking online learning; and ‘SWS’, during which the inputs were hippocampal replays of compressed sequences of experience. We tested the network in simulations of several well-known tasks that have shown considerable effects of SWS on performance in humans, including the Number-Reduction task and Paired-Associates.

Results: Running the network at ‘wake’ mode, the EC could extract only a limited structure in the inputs based on between-trial correlations. In contrast, at ‘SWS’ mode, the network utilized the compressed temporal sequences occurring during replays to extract input structures that extend over long durations and many trials. This new information allowed the EC to build more informative representations of the input and improved performance considerably, corresponding to human results.

Conclusion: Compressed sequences of learned episodes occurring during hippocampal replays form a perfect substrate for extracting fine temporal structure of experienced stimuli, one that is not easily accessed during online learning. This ‘temporal scaffolding’ may be the basis of the memory benefits seen in humans after sleep.

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0168

OSCILLATING SQUARE WAVE TRANSCRANIAL DIRECT CURRENT STIMULATION (tDCS) DELIVERED DURING SLOW WAVE SLEEP DOES NOT IMPROVE DECLARATIVE MEMORY MORE THAN SHAM: A RANDOMIZED SHAM CONTROLLED CROSSOVER STUDY*Sahlem GL¹, Badran B¹, Williams NR¹, Chicoree A¹, Strachan M¹, Bachman DL², Halford JJ², Uhde TW¹, Borckardt JJ¹, George MS¹*¹Department of Psychiatry, Medical University of South Carolina, SC, USA, ²Department of Neurology, Medical University of South Carolina, SC, USA

Introduction: Recent trials have demonstrated that anodal tDCS (both constant stimulation cycled off and on, and oscillating sine-wave) delivered bi-frontally during slow wave sleep has a beneficial effect in declarative, but not procedural memory. We investigated whether oscillating square wave stimulation produces the same result.

Methods: Twelve students (Age 25, 9F) free of medical problems underwent two testing conditions in a randomized counterbalanced fashion.

Condition one (Active) consisted of oscillating square wave tDCS delivered during early Non-Rapid Eye Movement (NREM) sleep. Condition two (Sham) consisted of setting up the tDCS device, but leaving it off during sleep. tDCS was delivered bi-frontally with anodes placed at F3/F4, and cathodes placed at mastoids. Current density was 0.517 mA/cm², and oscillated between zero and maximal current at a frequency of 0.75 Hz. Stimulation occurred during five-five minute blocks with one minute inter-block intervals (25 minutes total stimulation). The primary outcomes were both declarative memory consolidation measured by a paired word association test (PWA), and non-declarative memory, measured by a non-dominant finger-tapping test (FTT).

Results: The mean improvement in PWA recalled words during sleep was 3.3 for Active stimulation, and 3.8 for Sham stimulation. The mean improvement in FTT correctly typed sequences during sleep was 3.4 for Active stimulation, and 2.0 for Sham stimulation.

Conclusion: In this study, square-wave oscillating tDCS applied bi-frontally during early NREM sleep did not have a beneficial effect on either overnight declarative or non-declarative memory consolidation. It is unclear if the morphology of the tDCS pulse is critical in any memory related improvements, or not, if such an effect exists.

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0169

OSCILLATING AUDITORY STIMULATION DURING SLEEP CAN FACILITATE SLEEP SPINDLES*Antony J, Bae J, Paller K*

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Introduction: Two types of oscillations play particularly important roles in memory processing during sleep. Slow oscillations (< 1 Hz) occur most prominently during slow-wave sleep (SWS). Spindles are bursts of oscillatory activity between 11-16 Hz lasting 0.5-2 seconds occurring during stage-2 and SWS. Spindles occur non-uniformly across the scalp; frontal regions more prominently feature slow spindles (11-13.5 Hz) and centroparietal regions more prominently feature fast spindles (13.5-16 Hz) while also exhibiting slow spindles. Several methods have been used to show that facilitating slow waves can enhance memory, perhaps due to indirect effects on spindle activity. Here we attempted to manipulate spindles directly by presenting oscillating white-noise bursts at spindle frequencies during sleep.

Methods: Young, healthy subjects napped in the afternoon for up to 90 minutes with an auditory background of white noise. Following EEG signs of stage-2 or SWS, we presented 2-second bursts wherein the amplitude of white noise oscillated sinusoidally between 20-100% of the background amplitude at 12 Hz, 15 Hz, or 50 Hz. These three frequencies, corresponding roughly to slow spindle, fast spindle, and a non-spindle control frequency, respectively, were used in three different groups of subjects. Each burst was followed by 8 seconds of white noise at the background amplitude. Spindles were detected using an established automated algorithm.

Results: During 15-Hz stimulation, there was an increase in fast spindles relative to subsequent non-stimulation periods. Slow spindles did not differ between the stimulation and non-stimulation periods. During 12-Hz stimulation, there was only a trend for an increase in slow spindles. When spindle changes at the frontal and centroparietal scalp locations were analyzed separately, increases in both groups occurred over centroparietal electrodes, whereas no effects were observed over frontal locations. No effects were found with 50-Hz stimulation. Between-group comparisons confirmed that spindle frequency varied reliably as a function of stimulation frequency. Further analyses compared spindles during stimulation to spindles following stimulation. No differences were found in EEG power spectral density, duration, or topography, suggesting that induced spindles were physiologically similar to spontaneous spindles.

Conclusion: Prior findings have linked spindles with memory consolidation, general intelligence, and sleep stability. This successful demonstration of a method to facilitate spindles selectively and noninvasively opens the door to new research into the physiological functions of spindles and to practical applications of spindle-induction methods.

Support (If Any): This work was supported by the NIA grant T32 AG20506.

0170

ENHANCED SIGMA ACTIVITY IN EARLY VISUAL AREA DURING SLEEP ASSOCIATED WITH VISUAL PERCEPTUAL LEARNING

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Introduction: There are two dominant models on mechanisms of sleep's facilitatory effects on perceptual learning, use-dependent and learning-consolidation models. In the use-dependent model, sleep affects mechanisms used in a general manner before sleep, and the slow-wave activity (SWA) should be increased in the used brain region during subsequent sleep. The learning-consolidation model assumes that sleep affects mechanisms related only to learning, and sigma activity is increased during sleep. Here we tested which model is correct.

Methods: There were two conditions, learning and interference conditions. In the learning condition, one texture discrimination task (TDT) was trained. It is known that perceptual learning of TDT involves only the part of the early visual cortex that retinotopically corresponds to the trained visual field (trained region). In the interference condition, two different TDTs were serially trained. It is known that the trained region is used in both condition, but learned only in the learning condition, because learning of the two TDT interferes with each other in the interference condition. The use-dependent model predicts that the trained region should produce increased SWA during post-training sleep in both conditions, irrespective of whether the region was learned. In contrast, the learning-consolidation model predicts that only the learning condition should induce sigma increase in the trained brain region during post-training sleep.

Results: Young and healthy participants slept 90 min after TDT training and retested with TDT after sleep. Learning occurred only in the learning condition. EEG spectral analysis showed that the sigma activities (11-15 Hz) significantly increased in the trained compared to the untrained early visual area ($p < .05$) only in the learning condition during sleep. No SWA increase was found in both conditions.

Conclusion: These results are consistent with the learning-consolidation model. The use-dependent model may not be sufficient to explain the benefit of sleep on visual perceptual learning.

0171

SLEEP-DEPENDENT MOTOR LEARNING USING A COMPLEX MOTOR TASK

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Introduction: Improvements in performance when learning a novel, simple motor task are consistently seen following sleep, with smaller improvements seen during equivalent episodes of wakefulness. We sought to extend understanding of sleep-dependent motor learning by increasing motor task complexity and by examining agonist muscle activation efficiency.

Methods: 24 healthy adults (12F), aged 23.1 ± 3.8 y (Mean \pm SD) were trained and retested in three sequential visits (V) spaced 12 hours apart. Subjects were randomly assigned to one of two groups. Group 1 subjects began V1, 2 h following habitual waketime with a sleep episode

between V2 and V3. Group 2 subjects began V1, 14 h following habitual waketime with a sleep episode between V1 and V2. Performance on a trained and transfer movement using a well characterized lever-based motor task was assessed by absolute error in movement accuracy (AbsE) and maximum EMG amplitude per movement (MaxEMG) on two movement-specific agonist muscles (anterior deltoid, pectoralis major).

Results: Significant effects of visit were observed for AbsE in trained and transfer movements, MaxEMG amplitude of the pectoralis major in the trained movement ($P < 0.05$). Significant effects of group were observed for MaxEMG amplitude of the anterior deltoid in trained and transfer movements ($P < 0.05$). AbsE significantly decreased from V1 to V2 during wakefulness and V2 to V3 following sleep in Group 1 for the trained movement. MaxEMG amplitude of the anterior deltoid significantly reduced from V2 to V3 following sleep. A significant decrease was also observed in AbsE from V2 to V3 following sleep in Group 1 for the transfer movement. AbsE and MaxEMG amplitude of the pectoralis major significantly decreased from V1 to V2 following sleep for the trained and transfer movements in Group 2.

Conclusion: Sleep-dependent learning occurs using a more complex motor task, providing further evidence of sleep-dependent motor learning. In addition, efficiency of muscle movement appears to increase following sleep.

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0172

INDIVIDUAL DIFFERENCES IN SLEEP SPINDLES AND SLEEP-DEPENDENT MEMORY: THE IMPACT OF HABITUAL NAPPING

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Introduction: Habitual and non-habitual nappers have differences in daytime sleep architecture (McDevitt et al. 2012). This year, we also show that habitual nappers have greater sleep spindle densities than non-habituals (Reihanabad et al. 2014). Spindles are implicated in consolidation of memory during sleep. Here, we investigated sleep-dependent consolidation in habitual and non-habitual nappers on an associative memory task.

Methods: Twenty-five young, healthy subjects were categorized as habitual or non-habitual nappers. At 9 AM, subjects learned to associate 40 first and last names with faces. At immediate test and again at 4 PM, subjects were tested on three tasks: 1) free recall of names given a face, recognition of same and rearranged 2) first-last name pairings, and 3) face-name pairings. At 1:30 PM, subjects took a polysomnographically-recorded nap. The change in recognition discrimination index ($\Delta d'$) between test sessions was compared between groups. Spindle densities were calculated as spindles/minute of non-REM sleep, and correlated with behavioral measures.

Results: There were no differences in performance on the recall or face-name recognition tasks. However, on the first-last name recognition task, non-habitual nappers showed less forgetting than habituals. Habitual nappers had increased spindle densities at central and parietal sites compared to non-habituals. $\Delta d'$ was negatively correlated with spindle density in the full sample, and this effect was stronger in habitual nappers.

Conclusion: In contrast to other studies showing a positive association between spindles and declarative memory, our results suggest that spindles do not benefit associative verbal memory on a recognition task. Spindles correlated with increased false alarm rate at the trend level, consistent with our prior findings (McDevitt et al. APSS 2013). One possibility that needs to be tested is whether the correlation with false

alarms is due to better item memory, which increases familiarity of re-arranged pairs. In conclusion, habitual and non-habitual nappers may differ in sleep-dependent memory processes.

0173

A NAP RICH IN SLOW WAVE SLEEP SELECTIVELY PRESERVES EMOTIONAL SCENE COMPONENTS

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Introduction: Sleep selectively preserves aspects of memory most valuable to remember, such as emotionally salient information, over less relevant details. The emotional tradeoff effect, in which memory for the emotional focus of a scene is preserved at the expense of surrounding neutral information, is amplified by a period of sleep. However, the ideal composition of sleep involved in increasing the magnitude of this tradeoff is unclear.

Methods: Subjects viewed scenes containing an emotional or neutral foreground object placed on a neutral background. A baseline recognition test assessed immediate memory for half the encoded objects and backgrounds, presented separately, to ensure all groups encoded similarly. We then compared a period of wakefulness to a 90-min nap either early (11 am) or late (3 pm) in the day, with naps naturally differing in sleep stage composition. Retest on the remaining images occurred 7 hours after encoding, holding constant the time of training and testing between groups to control for circadian issues.

Results: While all groups performed similarly at baseline, there was a significant difference between groups at retest when examining the tradeoff between memory for negative objects and their corresponding backgrounds ($F_{2,43} = 3.35$, $p = .044$). While both nap groups performed better than the Wake group, a greater tradeoff emerged in the Late-Nap group compared to the Wake group ($t_{28} = -2.91$, $p = .007$). The Late-Nap group also achieved significantly more slow wave sleep (SWS) than the Early-Nap group (minutes, $t_{30} = -3.06$, $p = .005$; percentage, $t_{28} = -3.50$, $p = .001$), while the Early-Nap group obtained a higher percentage of Stage 2 sleep ($t_{28} = 2.86$, $p = .008$). Correspondingly, and in-line with behavioral findings, tradeoff scores correlated positively with SWS across both nap groups (minutes, $r = .38$, $p = .032$; percentage, $r = .44$, $p = .012$).

Conclusion: Taken together, this provides strong evidence that, for daytime naps, a greater period of SWS-rich sleep is necessary for the selective preservation of emotionally salient information.

0174

SLEEP AND THE FUTURE RELEVANCE OF EMOTIONAL MEMORIES

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Introduction: Sleep selectively benefits memory for salient information, including emotional information and information that participants are told they must later remember. However, it is unknown how these two salience cues interact during consolidation intervals that span wakefulness and sleep.

Methods: Participants encoded scenes in which a negative or neutral foreground object was placed on a neutral background. Half of the participants were then informed that they would be tested on these scene components, while the other half received no instruction.

Results: When no knowledge of the test was given, negative objects were well-remembered at the cost of the neutral backgrounds on which they were placed [$t(40) = 2.6$, $p = .01$]. However, this effect was observed only in participants who slept [$t(17) = 2.8$, $p = .01$]. When informed of the imminent testing, however, both the sleep [$t(20) = 6.0$,

$p < .001$] and wake groups [$t(19) = 4.7$, $p < .001$] displayed this tradeoff. Moreover, there was a three-way interaction among instruction (told vs. not told) \times valence (negative vs neutral) \times scene component (object vs. background) [$F(76) = 4.3$, $p = .04$] interaction. This was driven by superior memory for negative objects relative to their paired backgrounds when participants were informed of future testing, compared to when they were unaware [$t(76) = 2.6$, $p = .01$]. While the wake group showed a three fold increase in this difference score when the information was assigned future relevance [$t(39) = 2.02$, $p = .05$], there was no additional increase in the sleep group.

Conclusion: These results suggests that (1) future relevance and emotional salience interact to increase memory for the emotional component of a scene at the cost of memory for neutral backgrounds during a consolidation period filled with wakefulness, while (2) the sleeping brain already actively tags emotionally salient information as important for later memory, such that explicit instruction of an upcoming memory test does not further improve emotional memory.

0175

REM SLEEP AND RESTING CORTISOL INFLUENCE NEURAL ACTIVITY DURING EMOTIONAL MEMORY RETRIEVAL

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Introduction: Prior work in our lab has suggested that resting cortisol levels during encoding predict later emotional memory retrieval, but only if sleep occurs during a consolidation delay. It is unknown, however, whether a specific sleep stage modulates this memory enhancement. Based on prior evidence that emotional memory may specifically benefit from REM sleep, the present analysis examines whether REM sleep interacts with resting cortisol to influence subsequent memory performance.

Methods: Participants gave a salivary cortisol sample prior to encoding scenes consisting of a negative or neutral object placed on a neutral background. Participants then slept overnight, with their sleep monitored by polysomnography, and the next morning took a recognition test during fMRI.

Results: A whole-brain analysis was used to select regions in which greater %REM corresponded to greater successful retrieval activity to negative objects; these included the precuneus, precentral gyrus, lingual gyrus, insula, and cerebellum. For each of these regions, a linear regression analysis was computed, with the dependent variable being the difference in activity between hits to studied emotional objects and correct rejections to unstudied emotional objects. The independent variables were %REM, cortisol, and their interaction. In the precuneus, cortisol and %REM each predicted activity during negative object retrieval, as did the cortisol by %REM interaction (all $ps < .009$). Additional analyses showed that these effects were specific to REM sleep, as compared to other stages.

Conclusion: Building upon findings that cortisol and REM sleep have each been linked to enhanced emotional memory, results suggest that they not only separately, but also interactively, influence neural activity via greater engagement of the precuneus during retrieval. Particularly, REM sleep during consolidation may support successful emotional memory by leading to enhanced visual imagery during retrieval, as has previously been shown to be a function of the precuneus.

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0176

EFFECTS OF SLEEP-DEPENDENT CONSOLIDATION ON MEMORY FOR EMOTIONAL AND DISTINCTIVE COMPONENTS OF SCENES

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Introduction: Sleep has been previously shown to selectively enhance memory for salient and relevant information. This selective enhancement of memory after sleep is often observed for emotional information, which, by nature, is salient and often highly relevant. For example, post-learning sleep has been found to magnify emotional memory trade-offs, where episodic memory for salient aspects of emotional scenes is enhanced at the expense of the background, neutral information associated with the scene. Recently it has been demonstrated that distinctive, non-emotional stimuli can elicit similar memory trade-offs, suggesting that similar cognitive processes may underlie trade-offs for salient emotional and neutral information. However, it is unknown whether sleep also selectively enhances memory for distinctive emotional information. Therefore, the current study aimed to investigate the effect of sleep memory trade-offs for distinctive and emotional information.

Methods: Participants incidentally encoded scenes consisting of a central item (neither negative, positive, neutral or visually distinctive by emotionally neutral) against neutral scene backgrounds. After a 2.5 hr delay, during which a sleep group obtained a PSG-recorded nap and a wake group remained awake, recognition memory was tested for the objects and neutral backgrounds.

Results: Preliminary data shows that after a nap, memory for negative, positive, and non-emotional but visually distinctive objects increased compared to memory for neutral objects. Conversely, memory for backgrounds paired with negative, positive, and non-emotional but visually distinctive objects decreased compared memory for backgrounds paired with neutral objects. Therefore, sleep increased the memory trade-off effect for both emotional and distinctive objects and their associated backgrounds.

Conclusion: These findings suggest that sleep preferentially consolidates distinctive and emotional information. Furthermore, these findings illustrate that sleep may consolidate salient distinctive and emotional information through similar cognitive processes.

Support (If Any): Emory Neurosciences Initiative Seed Grant.

0177

THE EFFECT OF VALENCE ON SLEEP-DEPENDENT CONSOLIDATION OF EMOTIONAL MEMORIES IN OLDER ADULTS

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Introduction: Evidence suggests that aging may be accompanied by a bias in memory for positive versus negative information. Sleep is widely implicated in memory consolidation, showing a particularly strong effect on representations with emotional salience. However, sleep-dependent consolidation of emotional memories has typically been investigated in young adults. Therefore, whether sleep interacts with the “positivity effect” observed in older individuals remains unknown. The objective of the current study was to determine the effect of valence on sleep-dependent consolidation of emotional memories in older adults.

Methods: Healthy older (50-80 yrs) adults viewed a mixture of either negative and neutral pictures (Negative condition) or positive and neutral pictures (Positive condition) in either the morning (Wake groups) or evening (Sleep groups). Twelve hours later, participants underwent a recognition task in which they viewed the previously seen pictures (targets) intermixed with novel pictures and indicated whether they re-

membered each one. Overnight polysomnography was recorded for participants in the Sleep groups.

Results: In the Negative condition, there was no difference between the groups in the percent of either negative (Wake: $M = 80.06$, $SD = 11.24$; Sleep: $M = 80.25$, $SD = 14.56$) or neutral (Wake: $M = 80.20$, $SD = 14.93$; Sleep: $M = 79.32$, $SD = 12.65$) target pictures remembered. However, in the Positive condition, the Sleep group remembered significantly more positive ($M = 78.20$, $SD = 13.01$) and neutral ($M = 74.14$, $SD = 14.66$) target pictures than the Wake group ($M = 67.37$ and 65.26 , $SD = 17.26$ and 13.18 , respectively), $F(1,45) = 7.47$, $p < 0.05$. We expect memory performance in this condition to be related to characteristics of rapid eye movement sleep.

Conclusion: These findings suggest that sleep-dependent consolidation interacts with the positivity bias in older individuals, resulting in selective sleep-related processing of positive memories in this population.

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0178

STRESS EFFECTS ON CONSOLIDATION OF EMOTIONAL MEMORY TRADEOFFS AT 24 AND 48 HOURS

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Introduction: The brain prioritizes information to be remembered due to memory restrictions. This process is influenced by the valence and arousing nature of the information presented and the state of the brain. Our previous studies show emotional memory “trade-off effects,” where negative arousing objects are selectively preserved at the cost of memory for the neutral backgrounds on which they appear, compared to neutral objects on neutral backgrounds. Unknown, however, is how stress exposure and cortisol elevation affect consolidation of these memory trade-offs, especially over periods containing sleep. Previous studies demonstrated that stress exposure benefits negative information while impairing neutral information. We predicted stress exposure following memory encoding would produce larger benefits for negative objects and larger detriments to the neutral backgrounds on which they appear.

Methods: After encoding emotional and neutral scenes, participants underwent a psychosocial stressor. After a 24 or 48 hour interval, recognition memory was tested.

Results: While a significant three-way interaction was found between image component, valence, and condition after 24 hrs, $F(1,29) = 4.85$, $p = .036$, no significant three-way interaction was found after 48 hrs. Counter to predictions, stress did not intensify memory for negative emotional objects, but rather created a neutral object background tradeoff, $t(14) = 5.72$, $p < .001$ with increased memory for objects and decreased memory for backgrounds relative to a non-stressed control in which neutral objects and backgrounds are remembered equally well. However, this stress based neutral tradeoff disappears after 48 hours.

Conclusion: This tradeoff isn’t predicted by current literature and suggests stress exposure initially emphasizes object over background memory, regardless of valence for a short time (24 hours), but not long-term (48 hours). Previous studies suggest REM sleep strips arousal from memory through (re)encoding. Repeating this process to remove arousal from memory over a second night of sleep may de-emphasize stress arousal memory modulations of neutral stimuli.

0179

SLEEP AFTER REACTIVATION PREDICTS EPISODIC MEMORY UPDATING*Bryant N, Nadel L, Gomez R*

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Introduction: Previous research indicates that sleep facilitates memory consolidation. Reconsolidation occurs when a previously stabilized memory trace is reactivated, rendering it susceptible to change. New information can be integrated into the reactivated trace and will emerge following a period of restabilization. While sleep's role has been demonstrated in procedural memory updating, its function in the reconsolidation of episodes remains unknown. We hypothesized that sleep after reactivation of an episodic memory facilitates updating.

Methods: Sixteen undergraduates (9 female) tracked their sleep using actigraphy and a daily sleep diary during a week of memory testing. At Session 1 (Monday), participants learned 20 objects. At Session 2 (Wednesday), they were reminded of Session 1 (memory reactivation) and learned 20 new objects. At Session 3 (Friday), they were given an old/new recognition task that assessed their memory for the day on which they learned each object (Session 1 or 2). Intrusions were defined as the number of items misattributed to the wrong session. In prior studies, learners intruded Session 2 items into their memory for Session 1 but not Session 1 items into their memory of Session 2, demonstrating updating of a prior memory with later learning.

Results: Total sleep time (TST) the night following Session 2 learning was significantly positively correlated with updating, $r(14) = 0.593$, $p = 0.012$. TST on other days did not significantly predict this phenomenon. No significant relationships were found between TST and Session 1 items misattributed to Session 2.

Conclusion: These findings suggest that reconsolidation is supported by sleep in a manner similar to consolidation. Furthermore, this unidirectional effect indicates that this phenomenon is specific to memory updating instead of source memory errors. These results are an important first contribution to the investigation on sleep and episodic memory reconsolidation.

0180

SLEEP BENEFITS TO MEMORY TRAINING DECREASE OVER TIME IN RHESUS MONKEYS (MACACA MULATTA)*Templer V, Scullin MK*

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Introduction: Existing research in humans has shown a sleep benefit in various cognitive tasks occurring after the first day of learning, but few studies examine sleep effects after a second sleep interval. To assess the time course of sleep benefits to learning and to establish a strong animal model for the interaction of sleep and cognition, we analyzed existing data sets obtained from the first 10 days monkeys encountered an order memory task.

Methods: We retrospectively analyzed data from eighteen adult male rhesus monkeys (*Macaca Mulatta*) by evaluating accuracy on an order memory task in which monkeys were trained to select the earlier item from two items in a trial-unique sequence. Training benefits during the first session in day 1, last session in day 1, first session of day 2, and last session of day 2 were compared. The same analyses between first and last sessions of the day and between days were also made for days 3 and 4, and days 9 and 10.

Results: Accuracy significantly increased from the last session of day 1 to the first session of day 2 (i.e., over a nocturnal sleep interval), but did not significantly increase from beginning-to-end of day 1 or 2 (i.e., over diurnal wake intervals). Similar but less pronounced benefits were

found across days 3 and 4, but not across days 9 and 10, suggesting that over time sleep becomes less necessary as accuracy increases.

Conclusion: Rhesus monkeys appear to consolidate memories overtime and this consolidation process is likely benefited by nocturnal sleep. A novel finding that arises from this nonhuman primate model is that the largest learning benefit occurred after the first night of sleep, and that sleep-related benefits decreased as training experience increased. These results help validate monkeys as a useful animal model for the study of sleep and memory consolidation.

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0181

SLEEP-INDUCING DOSES OF GABA MODULATORS BUT NOT DUAL OREXIN RECEPTOR ANTAGONISTS IMPAIR RHESUS NIGHTTIME AROUSAL AND COGNITION*Tye SJ, Tannenbaum PL, Stevens J, Binns J, Savitz AT, Gotter A, Coleman PJ, Winrow CJ, Uslaner JM, Renger JJ*

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Introduction: Antagonism of dual orexin receptor (DORA) signaling promotes sleep across species by targeting wake promoting regions in the brain, whereas GABA-A modulators act to globally inhibit CNS activity. We previously demonstrated that DORA-22 promoted sleep in rhesus monkeys without associated cognitive impairments observed with GABA-A modulators when tested during the daytime, at Cmax, or the next morning (active phase). In the current study, we compare the nighttime (inactive phase) effects of pre-sleep administration of DORA-22, eszopiclone or diazepam on stimulus arousability gating and a psychomotor vigilance task (PVT).

Methods: Rhesus monkeys implanted with electroencephalogram, electromyogram and electrooculogram telemetry were evaluated for sleep/wake. At doses previously established to produce sleep, DORA-22 (3,10,30 mg/kg), eszopiclone (1,3,10 mg/kg) or diazepam (1,5,10 mg/kg) were administered 1 h prior to nighttime. Stimulus Arousability Gating: 12 rhesus monkeys were classically conditioned to reward (CS+) or not (Neutral) using two acoustical tones (700 or 1000 Hz; 3 s, 3X during 30 s, 3 dBA above background) presented 2 or 3 h into the night (~Cmax), counter-balanced. PVT: 12 trained rhesus monkeys were presented with a PVT on an in-cage touchscreen at 2 h into the night.

Results: At all doses of DORA-22, animals awoke during the night to the reward-conditioned stimulus but continued sleeping the majority of time through the neutral stimulus. In contrast, GABA-A modulators suppressed wake during both the reward and neutral acoustical stimuli. PVT performance was unchanged following DORA-22. In marked contrast, the GABA-A modulators resulted in significant performance deficits in PVT. Post-test latency to return to slow-wave sleep was reduced by both DORA-22 or GABA-modulators.

Conclusion: These nonclinical primate studies suggest that dual orexin antagonists such as DORA-22, unlike GABA-A modulators, promote sleep that preserves the capacity to wake to salient stimuli during the night and perform a complex task without impairment all while continuing to sleep uninterrupted through irrelevant acoustical stimuli.

0182

NO EFFECT OF TOTAL SLEEP DEPRIVATION ON RECALL OR GENERALIZATION OF EXTINGUISHED FEARStraus LD^{1,3}, Drummond SP^{1,2,3}, Acheson D^{1,2}, Risbrough VB^{1,2}¹Research Service, San Diego VA Healthcare System, San Diego, CA, USA, ²Department of Psychiatry, University of California-San Diego, San Diego, CA, USA, ³San Diego State University/University of California San Diego Joint Doctoral Program in Clinical Psychology, San Diego, CA, USA

Introduction: Fear conditioning is critical in the development and maintenance of PTSD symptoms, and extinction learning is necessary for treatment response. Animal studies have shown sleep disruption interferes with consolidation of extinguished fear. In humans, research suggests sleep promotes extinction recall and generalization, though no studies have demonstrated this experimentally. Here, we examined the effect of total sleep deprivation (TSD) on extinction recall and generalization.

Methods: Sixty-two participants (age = 24.0 ± 4.7 , 26F) underwent a laboratory paradigm to acquire conditioned fear to two visual cues. Both cues were paired with an unconditioned stimulus (US) 75% of the time. Twenty-four hours after fear conditioning, subjects underwent an extinction learning session, during which one of these visual cues (CS+E) was presented without the US. The other cue (CS+U) was not presented during this session and thus remained unextinguished. Subjects were then randomized to undergo one night of TSD (n = 22) versus one night of normal sleep (n = 40). Twenty-four hours after extinction learning, subjects underwent an extinction recall/generalization session, during which both cues were presented. Acoustic startle probes were delivered to measure subjects' reactivity to the CS+E and CS+U. Blink EMG magnitude was compared between the two groups.

Results: During the extinction recall session, the TSD group showed more reactivity to the CS+E than the well-rested group during early extinction recall (mean difference = 11.4). Similarly, the TSD group showed more reactivity to the CS+U during early (mean difference = 7.1) as well as late (mean difference = 20.2) extinction generalization. However, no differences were significant.

Conclusion: This was the first study to examine the effect of TSD on extinction recall and generalization in human subjects. Though previous research suggests sleep disturbance may impair extinction recall and generalization, these effects were not observed here. Future research should examine which aspects of extinction are potentially promoted by sleep, and under which circumstances these effects occur.

Support (If Any): DMRDP #DM102425.

0183

VISUAL DEPRIVATION HAS LOCAL EFFECTS ON EEG SPECTRAL POWER DENSITY DURING SLEEPRångtjell FH^{1,2,3}, Rupprecht Scherff R^{2,3}, Nguyen J^{2,3}, Rose D^{2,3}, Wamsley E^{2,3}, Stickgold R^{2,3}¹Uppsala University, Uppsala, Sweden, ²Harvard Medical School, Boston, MA, USA, ³Beth Israel Deaconess Medical Center, Boston, MA, USA

Introduction: The synaptic homeostasis hypothesis provides an elegant model for how wake synaptic strengthening is balanced during sleep by slow wave activity (SWA) dependent downscaling, proposing that local differences in synaptic strengthening across the brain are reflected in local differences in SWA. To test this model, we blindfolded subjects for 12 hours and measured SWA during the following night. Our hypothesis was that total visual deprivation would decrease occipital SWA, since lowering of input to the visual cortex would locally decrease synaptic strength, thus reduce SWA.

Methods: Each subject spent two 24-hour sessions in the sleep lab (n = 17), each beginning at 9 AM, and was blindfolded for the first 12 hours on one of these occasions. Subjects were then given an 8-hour sleep opportunity with PSG recording, including 60 channels of EEG. Sleep scoring was done according to AASM criteria and the first 60 minutes of NREM sleep was used for spectral power analysis using 0.5 Hz bins.

Results: Contrary to hypothesis, 12 hours of visual deprivation resulted in increased spectral power for slow oscillations (0.5-1 Hz; $p = 0.021$) and SWA (1.5-2.5, 3-3.5 Hz; $p \leq 0.036$) over the occipital region, compared to the control condition. Blindfolding also increased occipital power within the spindle range (12-13 Hz; $p \leq 0.025$) and for high alpha (10.5-12 Hz; $p \leq 0.045$). The parietal region demonstrated increased power after visual deprivation in slow oscillations (0.5-1 Hz; $p \leq 0.017$), SWA (1-4 Hz; $p \leq 0.016$), theta (4-6.5 Hz; $p \leq 0.039$), high alpha (11-12 Hz; $p \leq 0.020$) and spindle (12-12.5, 14.5-15 Hz; $p \leq 0.018$) ranges. No significant differences were seen frontally.

Conclusion: Contrary to previous findings, we found that depriving a sensory input increased SWA in the brain area receiving that sensory information. This does not necessarily disprove the synaptic homeostasis model; rather casting light on the complexity of brain function during sleep, and the difficulties in testing even the most elegant models.

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0184

EXERCISE HABITS MODERATES NAP'S EFFECT ON VISUAL-SPATIAL WORKING MEMORY

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Introduction: This study aimed to examine the relationship among sleep, exercise and visual-spatial working memory. As sleep and exercise have both been shown to benefit visual-spatial working memory and recent studies found that sleep problems (e.g. sleep-initiation difficulty) was negatively associated with exercise habits, we intend to explore if there was differential effect of a nap on exercisers' and sedentary adults' working memory.

Methods: Sixty-four university students (aged 17-25, 75% female) were recruited. Participants currently with membership of any sports team were classified as exercisers (39% of participants) and others as sedentary adults. Participants completed a 5-day sleep log for their habitual sleep-wake behaviors and the Pittsburgh Sleep Quality Index for their sleep quality. They were tested on the 2-back visual-spatial working memory task for two times, separated by either a 90-minute Polysomnography-monitored nap or wakefulness in quiet condition. Their difference on accuracy on test 1 and test 2 were calculated as the change-score, indicating their improvement/deterioration of working memory performance following the nap/wake-condition.

Results: Group differences for gender, age, body mass index, sleep quality and sleep duration were non-significant ($p > .05$). A 2×2 factorial design, with two between subject factors (exercise and nap-condition) revealed significant main effect of exercise, $F(1,63) = 5.744$, $p = 0.02$ indicating greater change scores in exercise group. There was also an interaction between exercise and nap-condition on the change-score, $F(1,63) = 4.13$, $p = 0.047$. Post-hoc analyses showed that among sedentary adults, napped participants had significantly higher change-scores ($p = 0.002$) than the wake-group, indicating better performance at test 2. Among exercisers, the change-scores in the nap- and wake-condition were not significantly different ($p > 0.05$).

Conclusion: While exercisers had better visual-spatial working memory than their sedentary counterparts, sedentary adults benefited from napping more than exercisers. Our finding suggested that sleep gain might enable sedentary individuals to catch up somewhat with exercisers in cognitive functioning.

0185

EFFECT OF REM-SPECIFIC OBSTRUCTIVE SLEEP APNEA ON SPATIAL NAVIGATIONAL LEARNING AND MEMORY

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Introduction: Given the general benefit of sleep on spatial memory and increased severity of obstructive sleep apnea (OSA) in REM, the current study asks whether disrupting REM sleep via sleep-stage specific OSA affects proper consolidation of spatial memories.

Methods: We recruited subjects with severe OSA (AHI4% > 30/hr) who are well treated and compliant with continuous positive airway pressure (CPAP). Individual subjects spent 2 different nights in the lab, during which subjects performed timed trials before and after sleep on one of two unique but equally difficult 3D spatial mazes. One night's sleep was normally consolidated with use of therapeutic CPAP throughout, while on the other night, CPAP was reduced only in REM sleep through the use of real-time PSG monitoring, thereby specifically disrupting REM sleep.

Results: REM disruption through CPAP withdrawal in REM both decreased the overall amount of REM (21.8% ± 5% during control sleep vs. 14.6% ± 5% with OSA in REM, $p = 0.009$, $n = 10$), and fragmented any remaining REM (REM Respiratory disturbance index = 11.0/hr ± 5 during control sleep vs. 45.1/hr ± 14 with OSA in REM, $p < 0.001$, $n = 10$). Total sleep time was similar (370.6 minutes ± 85 minutes during control sleep vs. 380.0 minutes ± 78 minutes with OSA in REM, $p = 0.375$, $n = 10$). Navigation performance measures include percent change across sleep in maze completion time (CT), total distance traveled (DT), and distance spent backtracking (BT). Our data suggest subjects show a poorer performance following a night with disrupted REM sleep, versus following a night with normal sleep consolidation (CT = +31.4% ± 31.2% across consolidated sleep vs. -11.9% ± 44.9% with OSA in REM, $p = 0.02$, $n = 10$). Similar trends were seen for DT and BT. Importantly, these changes in maze performance were not accompanied by changes in psychomotor vigilance on a 20-minute psychomotor vigilance test (mean reaction time = 268 sec ± 24 sec across consolidated sleep vs. 256 sec ± 20 sec with OSA in REM, $p = 0.06$, $n = 10$).

Conclusion: REM disruption appears to impair consolidation of spatial navigational memory.

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0186

THE EFFECT OF OBSTRUCTIVE SLEEP APNEA ON DECLARATIVE MEMORY CONSOLIDATION

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Introduction: Patients with sleep disordered breathing demonstrate poor sleep quality along with various levels of cognitive deficits. The aim of this study was to test the hypothesis that patients with obstructive sleep apnea exhibit only practice-related learning on a declarative memory task and lack the normal learning benefit that occurs during sleep.

Methods: A total of 60 participants (mean age 41.2 ± 14.5 years) were included, 30 healthy controls and 30 participants newly diagnosed with obstructive sleep apnea (mean AHI 34.8 ± 28.4/h). After a baseline screening polysomnogram (PSG), they subsequently underwent an

overnight testing session, which included the Psychomotor Vigilance Task (PVT) and the declarative Verbal Paired-associates Task (VPA) in the evening followed by a full night PSG and repeat PVT and VPA sessions in the morning.

Results: Both group showed similar learning of the VPA in the evening. However the healthy control group showed significantly higher morning scores (83.3%vs.73.9%; $p = 0.001$) along with more overnight improvement compared to the OSA patients (13.6%vs.5.9%; $p = 0.002$). There was a significant difference in time spent in N3 sleep between the two groups during the test night (11.9%vs.4.4%; $p = 0.001$), not observed during the adaptation night. Morning retention of the VPA correlated with the amount of slow wave sleep ($p = 0.001$) and average nocturnal oxygen saturation ($p = 0.03$). PVT baseline average reaction time at night and the average reaction time in the morning showed no significant difference between the two groups.

Conclusion: Our results demonstrate that while subjects with sleep-disordered breathing show similar initial learning (encoding) on a declarative memory task compared to healthy controls, they perform significantly worse after a night of sleep. This could be due to the deficiency in generating slow wave sleep, which is associated with more efficient memory consolidation.

Support (If Any): K23 HL103850, American Board of Sleep Medicine Junior Faculty Research Award.

0187

THE ROLE OF SLEEP IN SPEECH MOTOR SKILL**LEARNING: BEHAVIORAL AND KINEMATIC EVIDENCE**

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Introduction: While sleep has been shown to play a role in the learning of simple motor tasks, little is known about sleep-dependent improvements in learning of complex motor tasks such as speech. Therefore, the aim of this study was to determine if (and the extent to which) post-sleep benefits are noted in speech motor performance relative to an equivalent period of time awake.

Methods: Twenty healthy, monolingual English-speaking young adults with no history of speech-language or sleep disorders and with regular night-time sleep durations (7-9 h per night) were randomly assigned to one of two groups: MEM ('Morning-Evening-Morning') or EME ('Evening-Morning-Evening') testing. After initial training on two novel speech tasks (a nonword repetition and timed sequence repetition task), either in the morning (MEM group) or in the evening (EME group), participants' retention was tested after 12 h and 24 h. Order of speech tasks was random for each participant for each session. High quality audio and kinematic recordings were obtained and assessed for accuracy, speed and speech movement coordination.

Results: For several measures of speech skill, enhanced performance was noted after a period that included sleep relative to an equivalent time period awake. For the nonword repetition task, significant post-sleep gains were noted only in the MEM group for speech movement coordination and speed of production (both $p < .05$). For the timed sequence repetition task, post-sleep performance benefits were seen in both the MEM ($p < .05$) and EME groups ($p < .01$) for accuracy measures. Additionally, significant gains in speech production speed were also noted after a period of sleep for this task (MEM: $p < .05$; EME: $p = .06$).

Conclusion: Our findings offer support for sleep-dependent improvements in a complex skill such as speech, which involves the integration of language and cognition with motor performance.

Support (If Any): Innovative Seed Grant Program at the University of Colorado-Boulder.

0188

SLEEP FRAGMENTATION AND LANGUAGE IN TODDLERS WITH DOWN SYNDROME

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Introduction: Previous studies have suggested that sleep plays an important role in memory consolidation and abstraction of concepts, two functions that may support language development. Down syndrome (DS), the most common genetic disorder resulting in intellectual disability, is characterized by sleep disturbance, with up to 80% of the DS population displaying obstructive sleep apnea syndrome (OSAS). In a recent study, Breslin, Spanò, Bootzin, Anand, Nadel, & Edgin (in press) examined the effect of OSAS on cognition in 38 individuals with DS ages 7-18 years. The findings demonstrated that children DS comorbid for OSAS had lower performance in a test of cognitive flexibility and lower verbal IQ scores as compared to children who did not have OSAS. Given these findings, more work is needed to determine the severity of sleep problems across development in DS and the impact of these problems on cognition, specifically language development.

Methods: In the present study we assessed the relation between sleep disturbances and language acquisition in toddlers with DS ages 2-5 years old ($n = 27$). Participants' pattern of sleep was assessed using movement monitoring during sleep (actigraphy) in conjunction with a sleep diary across seven consecutive nights. The MacArthur-Bates Communicative Development Inventory and the LENA Language Environment Assessment were employed to measure language.

Results: Increased sleep fragmentation was correlated with parent report of vocabulary ($r = -0.60$, $p = 0.001$). There was also a trend between sleep fragmentation and LENA mean length of utterance ($r = -0.35$, $p = 0.07$).

Conclusion: These results suggest that one important factor relating to language impairment may be a child's severity of sleep fragmentation. These results highlight the need for individuals with DS to receive early screening and treatment for sleep disorders.

Support (If Any): This research was funded by the Thrasher Research Fund, Down Syndrome Research and Treatment Foundation, Research Down Syndrome.

0189

A NAP AND ITS RELATIONSHIP TO CONSOLIDATION AND RETENTION OF NEW LEARNING IN 6.5 MONTH OLDS

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Introduction: There has been little research assessing the role of sleep in infants' ability to learn complex statistical information. Gomez and colleagues (2006) demonstrated that with a period of sleep, 15-month-old infants are able to generalize patterns of language to novel exemplars. At 6 months of age, identifiable adult-like stages of sleep, NREM 1, 2, 3, and REM are present (Jenni, 2004). Using stimuli from Thiessen & Saffran (2003) who demonstrated that 6-month-olds are able to track conditional probabilities to extract words from running speech in an artificial language, we asked if a period of sleep might correlate with later retention. This research is the first to use polysomnographic recordings to assess the role of sleep in infant learning.

Methods: Ten 6.5-month-olds were familiarized with an artificial language prior to the first nap of the day. Polysomnography was adminis-

tered after learning. After the nap, all infants were tested for retention of words vs. partwords of the artificial language. Automatic sleep spindle detection was performed using methods described in Ferrarelli et al. (2007).

Results: Infants' sleep morphology demonstrated great variability. Despite similar amounts of sleep time the night prior ($M = 9.7$, $stdev = 1.85$), infants' nap times ranged from 28 to 82.5 minutes ($M = 53.81$, $stdev = 24.9$). Infants spent significantly more time in NREM2 and NREM3 ($M = 48.81$, $stdev = 24.7$) than REM sleep ($M = 10.54$, $stdev = 10.55$) ($t(9) = 5.39$, $p > .01$). Preliminary analyses reveal a trend in discrimination as a function of spindle density in NREM ($r = .61$, $N = 10$, $p = .058$).

Conclusion: This research makes two important contributions: It is the first to 1) assess nap morphology in such young infants, and 2) relate infant naps at the earliest emergence of adult-like stages and memory-related physiology (sleep spindles) to stabilization and strengthening of memories. Data collection is currently ongoing.

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0190

THE ASSOCIATION BETWEEN SLEEP AND REPORT CARD MARKS IN HEALTHY SCHOOL-AGE CHILDREN

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Introduction: Academic success plays an important role in improving future lifetime opportunities. Accumulating evidence indicates that sleep has beneficial effects on academic success. Numerous factors have been identified as being relevant to academic achievement, but the role played by sleep in this process has been largely ignored. A considerable proportion of elementary school-aged children sleep for less than the recommended hours per night and 25-40% of youth are affected by asleep disorder during infancy, childhood and/or adolescence. This is a major concern given that restricted sleep can negatively impact the academic performance of children. Measures used to assess school achievement include report cards marks. Previous studies examining the associations between sleep and marks on report cards used subjective measures of sleep. Thus, we do not know what aspects of sleep are related to performance in specific academic subjects or which aspects of sleep are most relevant to academic performance. Determining which aspects of academic performance are specifically affected by poor sleep is important because this can inform the development of sleep interventions to improve these domains. The goal of the present study was to examine the association between objectively measured aspects of sleep (sleep duration and sleep efficiency) and report card marks in healthy school-age children.

Methods: Nighttime sleep was monitored by actigraphy (AW-64 series, Mini-Mitter) to evaluate sleep through the measurement of ambulatory movement, and parents provided their child's most recent report card. The study sample consisted of 72 participants between the ages 7 of 11 years (mean = 8.85, $SD = 1.6$).

Results: The amount of sleep that children obtained gradually decreased with age. Children in Cycle 1 obtained an average of 608.21 minutes ($SD 24.65$), while those in Cycle 2 received 565.7 minutes ($SD 26.15$) and those in Cycle 3 received 547.43 minutes ($SD 34.5$) [$F(2,69) = 24.65$, $p < 0.0001$]. Using multiple linear regression analyses it was found that higher sleep efficiency showed a statistically significant association with better marks in Math, English Language, and French as a Second Language above and beyond the contributions of age, gender, and socioeconomic status.

Conclusion: Our findings suggest that higher sleep efficiency in healthy school-age children is positively associated with better marks in Math, English Language and French as a Second Language.

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0191

EVALUATING THE RELATIONSHIP BETWEEN SUBCOMPONENTS OF IMPULSIVITY AND SLEEP QUALITY

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Introduction: Understanding the degree to which sub-components of impulsivity (e.g. attentional, motor and non-planning impulsivity) are accounted for by sleep quality indices could aid in the management of impulsive behavior. Impulsivity is a hallmark symptom of poor decision-making, attentional disorders, and deficits in executive functioning. Poor sleep quality is known to increase impulsivity, which may lead to even greater disinhibition. We aimed to investigate the relationship between attentional, motor, and non-planning impulsivity and sleep quality in a healthy young adult population.

Methods: A total of 80 healthy undergraduate college students (57.5% women; $M = 20.37$ years, $SD = 2.28$) were administered a series of self-report questionnaires, including the Barratt Impulsiveness Scale (BIS) comprised of attentional, motor, and non-planning subscales and the Pittsburgh Sleep Quality Index (PSQI), comprised of sleep quality, latency, duration, efficiency, disturbance and medication component scales.

Results: Poorer sleep quality on the PSQI Global score was moderately associated with heightened attentional impulsivity ($r = .29$, $p = .01$). Similarly, the PSQI sleep quality subscale score positively correlated with both attentional ($r = .32$, $p < .01$), non-planning ($r = .33$, $p < .01$) and motor impulsivity ($r = .24$, $p = .03$). In contrast, other PSQI subscales, namely those that index sleep quantity—sleep efficiency, sleep duration, sleep onset latency, sleep disturbance—as well as daytime dysfunction and sleep medication subscales, did not account for variance in impulsivity.

Conclusion: Impulsivity appears to be more strongly associated with an individual's perception of sleep quality than self-reported, quantitative indices of sleep (e.g., sleep length). These findings suggest that a patient's perception of their sleep quality may have a greater impact on task orientation, attention, motor control and, ultimately, decision-making.

0192

A COMPARISON OF CHRONOTYPE ON NEUROCOGNITIVE AND TRAIT INDICES OF IMPULSIVITY

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Introduction: This is the first study designed to investigate the link between self-report of trait impulsivity and neurocognitive impulsivity amongst chronotypes. This is important given that evening-types may engage in more impulsive, deleterious health behaviors. We hypothesized that evening-types would report greater impulsivity and show poorer performance on neuropsychological measures.

Methods: Participants ($n = 83$; 59% female) completed the Morningness-Eveningness Questionnaire, used to classify participants by chronotype. A total of 14 morning-type, 34 intermediate-type, and 31 evening-type participants completed the Barratt Impulsivity Scale (BIS) and neuropsychological measures of executive functioning and impulsivity: Trails A, Trails B, the Zoo Map Test (ZMT), The Iowa Gambling Test (IGT), and The Maze Test.

Results: Evening-types ($M = 53.77$, $SD = 9.86$) reported significantly higher impulsivity compared to morning- and intermediate-types ($M = 49.35$, $SD = 8.66$) according to the BIS total score ($t(81) = -2.14$, $p < 0.05$, and Attentional subscale ($t(81) = -2.09$, $p = 0.05$). Further examination of the strength of the relationship between the neuropsychological measures and BIS subscales revealed modest significant correlations between the Attentional subscale and ZMT planning ($r = -0.20$), solving ($r = -0.31$) and Maze Trace ($r = 0.21$); the Non-Planning scale and ZMT planning ($r = -0.21$), ZMT profile score ($r = -0.32$), Trails A ($r = 0.25$), and IGT ($r = -0.28$); the Motor scale and ZMT plan time ($r = -0.33$).

Conclusion: Evening-types reported more impulsive attentional tendencies, which may contribute to their associated dysfunctional behavioral patterns, such as a higher frequency of substance use, impulsive eating, and irregular sleep scheduling. Future research should investigate whether neurocognitive measures that are more sensitive to attentional impulsivity detect behavioral differences between the groups.

0193

THE ROLE OF SLEEP QUALITY IN THE RELATIONSHIP BETWEEN GENDER AND RISKY DECISION-MAKING

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Introduction: Studies showed that sleep-deprived individuals make more risky decisions, are more reward-orientated, and less sensitive to aversive outcomes in situations that involve risk-taking. These effects of sleep deprivation were found in women but not in men. The current study proposed that poor perceived sleep quality would similarly interact with gender in predicting risk-taking tendency.

Methods: Seventy-seven individuals completed the Pittsburgh Sleep Quality Index on their perceived sleep quality over a one-month period. Using a cut-off score of 5, 18 participants (age = 20.06 ± 2.03 , 6 male) were classified as poor sleepers. Participants completed the Risky-Gains Task (RGT), which measured the number of risky choices made in general and the number of risky choices made following a punishment trial as their risk-taking tendency and punishment learning behavior, respectively.

Results: Group differences in age, gender, body mass index, and habitual sleep duration were non-significant ($ps > .05$). A 2×2 factorial ANOVA revealed a significant interaction effect between gender and perceived sleep quality on risk-taking tendency, $F(1,74) = 4.659$, $p = .034$, and punishment learning behaviors, $F(1,74) = 4.328$, $p = .041$. No other significant results were observed ($ps > .05$). Post-hoc analyses showed that among normal sleepers, men made fewer risky decisions in general than women ($p = .034$), while their punishment learning behaviors were not statistically different ($p > .05$). Yet, among poor sleepers, while the number of risky decisions did not statistically differ across genders ($p > .05$), men had significantly fewer punishment learning behaviors than women ($p = .030$).

Conclusion: Our findings showed that perceived sleep quality moderated the effect of gender on risk-taking and punishment learning behaviors. Contrary to the effects of sleep deprivation, poor sleep quality was associated with worse punishment learning behaviors in men but not in women, even though men with good sleep quality had fewer risk-taking behaviors than women. This study highlighted the importance of considering sleep in the study of gender differences in risky decision-making.

0194

WAKE UP AND SMELL THE COFFEE: DIFFERENTIAL EFFECTS OF CAFFEINE ON A VISUAL SELECTIVE ATTENTION TASK

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Introduction: Caffeine is a popular stimulant used by a number of people to help them feel more awake and alert during times of fatigue. Research suggests that caffeine may play a major role in boosting visual attention during times of fatigue (Lorist & Snel, 1997). The Ericksen flanker task is a commonly used assessment of response inhibition and selective attention. In this task, directional responses are made about a central target that is surrounded by “flanking” stimuli. These stimuli face in either the same direction as the target, facilitating target identification (congruent), the opposite direction as the target, inhibiting target identification (incongruent) or have no indicated direction (neutral).

Methods: Our study explored the role of caffeine in helping or hindering young adults perform a selective attention flanker task. A group of 53 relatively young (mean age = 19.02) introductory level undergraduate students (female = 30) were instructed to look at a fixation cross in the center of a computer screen and identify whether the center arrow was pointing left or right. Participants indicated (via post-experiment questionnaire) if they had consumed caffeine that day.

Results: ANOVA results showed an overall effect of caffeine ($F(1,42) = 9.94$; $p < .005$) and congruency ($F(2,41) = 13.4$) in the flanker task. There was a significant interaction found between caffeine and congruency $F(2,41) = 4.32$, $p < .005$. Additionally, morning test-takers who consumed caffeine were significantly more accurate during incongruent trials than morning test-takers who did not consume caffeine prior to test-taking ($p < .01$) and afternoon test-takers who did consume caffeine prior to test-taking ($p < .01$).

Conclusion: Caffeine consumption specifically improved college students' ability to inhibit visual information that interfered with task performance. The effect of caffeine on the attentional capacity of young adults may be greatest in the morning ($p < .08$), when college-aged students are typically least alert.

0195

THE EFFECT OF CAFFEINE GUM ON PSYCHOMOTOR VIGILANCE TASK AND SIMULATED DRIVING PERFORMANCE DURING SLEEP INERTIAMarkwald RR¹, Bessman SC¹, Drummond SP^{2,3}, Sessoms PH¹, Reini LA¹

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Introduction: Caffeine gum (CG; 100 mg) has recently been reported to improve psychomotor vigilance task (PVT) performance during sleep inertia. We sought to examine the effect of 200 mg CG on neurobehavioral performance, simulated driving, and subjective sleepiness during sleep inertia.

Methods: As part of an ongoing study, 12 healthy adults (9 active-duty military) aged (30.1 ± 7.2 years; mean \pm SD) completed two overnight sleep laboratory visits. In a counterbalanced crossover design, 200 mg CG or placebo gum (PL) was administered doubleblind immediately upon awakening from a scheduled 2 h overnight sleep episode. Sleep was monitored using a validated wireless system. A 10-min PVT and simulated driving task including a divided attention component were given at 5 and 16 min after awakening, respectively. Karolinska Sleepiness Scale (KSS) for subjective sleepiness was administered before and after the PVT and driving task. Repeated-measures ANOVA and paired

t-tests examined differences in PVT median reaction time (medRXT), simulated driving speed variability (SV), and divided attention task response time (DivAttRT) between a pre-sleep baseline, PL, and CG conditions.

Results: Compared with baseline, PVT performance was worse and KSS scores were higher during sleep inertia; however, CG significantly improved PVT medRXT compared with PL (all $P < .05$). There was no difference in KSS scores between CG and PL ($P > .05$). A nonsignificant trend between CG and PL was revealed for DivAttRT ($P = .053$) and SV ($P = .092$).

Conclusion: These preliminary results indicate 200 mg CG improves PVT performance during sleep inertia despite a lack of change in subjective sleepiness levels. Nonsignificant trends in the predicted direction also suggest CG may hold promise for combating sleep inertia impairments in simulated driving. These findings provide more support for CG as a countermeasure for sleep inertia from unexpected nocturnal awakenings.

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0196

SLEEP HABITS, CELL PHONE USE, AND PERCEIVED STRESS IN TRADITIONAL-AGE COLLEGE STUDENTS

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Introduction: Partial sleep deprivation (PSD) is common among college students and is associated with deficits in cognitive functioning, health, and overall well-being. Poor sleep quality associated with higher negative moods, higher stress levels, twice as likely to report using over-the-counter (OTC) or prescription stimulant. Research has consistently shown that perceived stress (both emotional and academic) is associated with poor sleep quality. Research has also demonstrated cell phone use may impact sleep onset latency. The current study aims to determine the sleep hygiene, morningness-eveningness typology, cell phone use, and perceived stress levels at James Madison University.

Methods: Undergraduate students ($N = 245$, 18-24 years old) participated in an online survey, which was comprised of the following: a sleep hygiene survey that was adapted from the Pittsburgh Sleep Quality Index (PSQI), the Morningness-Eveningness Questionnaire (MEQ), a perceived stress survey adapted from the Perceived Stress Scale (PSS), and general demographic questions.

Results: Preliminary data analysis revealed positive correlations between students' frequency of reported naps and GPA ($p < .05$, $r = .127$), weekday time in bed (TIB) and reported concentration ability ($p < .001$, $r = .229$), weekday TIB and reported mood ($p = .019$, $r = .150$). Negative correlations were found between students' reported napping frequency and perceived impact of sleep deprivation on stress levels ($p < .001$, $r = .229$). Ninety-three percent of students reported sleeping with their phone in or next to their bed, while 78% of students reported using their cell phones after intending to go to sleep.

Conclusion: The sleep habits of traditional aged college students play a significant role in their well-being along with academic success. Additional data is being collected on total sleep times in fall compared to spring. Future studies need to be performed to better understand the relationship between students' sleep habits and their academic success.

0197

LONG LECTURES LEAD TO STUDENT SLEEPINESS AND DISENGAGEMENT: DOES AN INTERVENTION HELP?*Snyder M¹, Artis JT¹, Surber T¹, Harsh J¹, Han G²*¹The University of Southern Mississippi, Hattiesburg, MS, USA,²Marian University, Fond du Lac, WI, USA

Introduction: Many college students have poor sleep health leading to chronic and excessive daytime sleepiness. High student sleepiness is associated with poor academic performance. In a previous study of students in multiple courses and disciplines, we described that likelihood of acute severe sleepiness (equivalent to staying up all night) increased from low at the beginning of lectures to high (up to > 70% of students) as lectures progressed. This study assessed whether the time course of emergent sleepiness during lectures can be altered using in-class intervention strategies consisting of a strategically-placed 5 minutes of a word-search or cross-word puzzle (based on lecture material and graded) or five minutes of free time.

Methods: Data were collected from 90 college students in 2013. Starting at the beginning of each of six 75-minute lectures on statistics, students were signaled at 10-minute intervals to rate (using clickers) their subjective sleepiness (using Stanford Sleepiness Scale, SSS) and level of lecture engagement (an 8 point scale). Three lectures were baseline (no intervention) and three were intervention. At the beginning of intervention lectures, students were told that after 25-min of lecture, they would participate in one of three interventions but not which one. Students participated in a different intervention on each of the three intervention lectures.

Results: Mixed model ANOVA revealed that both acute sleepiness (SSS > 5) and lecture disengagement (rating > 5) during baseline lectures increased with lecture time. Each of the in-class interventions led to significantly lower proportions of acutely sleepy and disengaged students although both sleepiness and disengagement increased (more slowly than baseline) after the intervention.

Conclusion: Sitting in a lecture unmask sleep propensity. Sleepiness and engagement can be maintained at higher levels with in-class interventions. Anticipation of the graded intervention appears to be an important component of the effect.

0198

FACTORS ASSOCIATED WITH FREQUENT NIGHTMARES AMONG THE GENERAL FINNISH ADULT POPULATION

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Introduction: Cross-culturally, the prevalence of frequent nightmares among the general adult population is 3-5%. Previous studies have shown that frequent nightmares are often accompanied by other sleep problems as well as mental health problems, but comprehensive population based studies are rare. The current study focused on the factors associated with frequent nightmares among the general Finnish adult population. The aim was to investigate several previously unexplored potential contributing factors to nightmares as well as to test whether many already known correlates of nightmares can be replicated in these data.

Methods: Our study utilized two surveys of the Finnish National FINRISK study. FINRISK is large scale health survey collected every 5 years starting from 1972. The surveys consist of random cross sectional population samples from adults aged 25-74 who fill in a comprehensive health questionnaire including items on sleep and mental well-being and participate in a physical examination at local healthcare center. In the current study surveys from years 2007 and 2012 were used (N = 13 922).

Results: Our analyses show that insomnia and depression symptoms as well as the use of hypnotics and antidepressants are factors most strongly associated with frequent nightmares in these data. Strong associations also exist between nightmares and physical pain and the use of painkillers, life dissatisfaction, self-estimated poor physical health and several measures of self-estimated anxiety and stress symptoms. Other significant factors associated with frequent nightmares include short and long sleep patterns and hostile personality.

Conclusion: Frequent nightmares are associated with several factors related to physical and mental well-being.

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0199

GENDER AND AGE DIFFERENCES IN THE DREAMS OF ADOLESCENTS AND YOUNG ADULTS

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Introduction: Few studies have examined age and gender differences in adolescence and young adulthood. With the exception of studies by Hall and Domhoff in the 1960s, these studies have compared their findings with normative data for young adults instead of contemporary samples. The current study collected a new and updated relatively large sample of both young adults and adolescents in order to examine both age and gender differences in dreams using the dream diary method of dream collection.

Methods: Fifty male and female adolescents ages 12-17 and fifty male and female young adults ages 18-24 (N = 200) kept a diary of the day's

events and dreams for 10 days. One dream per participant was scored by two independent judges, with inter-rater reliability, using the Hall and Van de Castle (1966) method of content analysis. All variables were controlled for dream report length by dividing by word count and DreamSAT was used for statistical comparisons.

Results: Two by two factorial ANOVAS with gender and age as factors revealed significant main effects for gender. More specifically, males had more physical aggression, less total friendliness, and a lower friendliness per character index. Females had more female and family characters and more verbal activities. Results also revealed significant main effects for age. More specifically, adolescents had more strange and animal characters and more total activities.

Conclusion: Results are consistent with previous research on gender differences and confirm their consistency since the studies of the 1960s. The observation of fewer animal characters in dreams in young adulthood compared to adolescence is also consistent with the previously established developmental decrease in the presence of animal characters in dreams from early childhood to adulthood.

Support (If Any): Social Sciences and Humanities Research Council of Canada.

0200

DREAMING IN N2: POSSIBLE EEG AND SPECTRAL INDICES

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Introduction: A debate persists concerning dreaming in Stage 2 Non-REM (N2) sleep. Aiming to cast light on that longstanding debate, this study examined EEG morphology in N2 and the spectral structures corresponding to the EEG.

Methods: In the electrographic records of nocturnal sleep in ten healthy college students, K complexes (KCs) and sleep spindles were analyzed at loci in the sleep cycle where N2 dreaming has been predicted or observed: at transitions to or from Stage REM anywhere in the sleep cycle, and in late sleep regardless of proximity to REM.

Results: EEG: Both unitary KCs and KC bursts occurred in distinctive series during peri-REM sleep across the sleep cycle, particularly in the pre-REM period. KC bursts varied in morphology. Inter-KC frequency and inter-KC burst frequency varied. Occasionally, KC series replaced an expected initial REM period. As expected, KC series also preceded arousals. KC series were particularly striking in FZ. Sleep spindles, typically obscured by high amplitude slow waves in early sleep, were often concatenated in series in middle and late sleep. Spindle series, bracketed or not by KCs, were more common post-REM than immediately pre-REM. Spindle series were striking in PZ. Spectral analysis (FFT): Where KCs in series delineated a "comb" in the time domain, the series' spectral transform often did so as well. The morphology of this familiar Fourier transform pair was best articulated immediately pre-REM. Spindle series, in whole or in part, often produced Gaussian spectral profiles—again, a fundamental Fourier pairing. In pre-REM sleep and pre-arousal, spectral profiles tended to become less Gaussian. Occasionally in late sleep or in late pre-REM sleep, peak spindle frequency increased.

Conclusion: In N2 in the vicinity of REM sleep and in late sleep, EEG patterns and their spectral equivalents might illumine the physiology that underlies non-REM states of REM-like dreaming (Nielsen's "covert REM").

0201

TNFA 308 POLYMORPHISM PREDICTS RESILIENCE TO PSYCHOMOTOR VIGILANCE PERFORMANCE IMPAIRMENT DURING TOTAL SLEEP DEPRIVATION IN A SAMPLE OF HEALTHY YOUNG ADULTS

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Introduction: There are considerable, trait-like inter-individual differences in neurobehavioral performance deficits due to total sleep deprivation (TSD). Preliminary results from our laboratory suggested that a tumor necrosis factor alpha (TNF α) polymorphism, a single nucleotide change from G to A at position 308, may mediate resilience to neurobehavioral impairment in response to TSD and sustained sleep restriction. Here, we analyzed additional data from TSD studies to further investigate this finding.

Methods: N = 87 carefully screened, healthy young adults (28.0 \pm 5.4 years; 45 females; 66 White, 9 Black or African-American, 3 Asian, 2 Hispanic, 1 American-Indian or Alaska Native, 5 mixed race, 1 unknown) participated in one of five laboratory studies with 38 h or 62 h TSD. Following one or two adaptation and baseline days and nights, a psychomotor vigilance test (PVT) was administered at 2 h intervals during the TSD period. The average number of lapses of attention (RTs > 500 ms) on the PVT during hours 14 through 38 of scheduled wakefulness (i.e., averaged across a circadian cycle) was determined as an index of resilience to TSD. Subjects' DNA was extracted from whole blood samples. TNF α 308 genotypes were assayed, blind to PVT performance outcomes, using polymerase chain reaction (PCR) followed by gene-specific restriction enzyme digestion and visualized by electrophoresis on 3% agarose gel.

Results: The distribution of genotypes in this sample (G/G: 73%; A/G: 25%; A/A: 2%) was found to be in Hardy-Weinberg equilibrium ($X^2_2 = 0.82$, $P = 0.66$). Non-parametric analysis of subjects' TSD resilience rankings as determined by their average PVT lapses, controlling for study, showed that TNF α 308 genotype was associated with inter-individual differences in neurobehavioral performance responses to TSD ($F_{2,80} = 4.63$, $P = 0.013$). Individuals heterozygous or homozygous for the A allele showed greater resilience to TSD. There was no significant effect of study ($F_{4,80} = 1.15$, $P = 0.34$). Secondary analyses indicated there were no significant effects of race ($F_{5,78} = 0.80$, $P = 0.55$), gender ($F_{1,83} = 0.51$, $P = 0.48$), or age ($F_{1,83} = 0.04$, $P = 0.85$).

Conclusion: In this sample of healthy young adults, the A allele for the TNF α 308 locus predicted greater resilience to psychomotor vigilance performance impairment due to TSD. It remains to be determined whether this genotype-phenotype association generalizes to other cognitive performance tasks and other sleep deprivation conditions such as chronic sleep restriction.

Support (If Any): NIH grants R01HL70154, R01HL105768 and R21CA167691; USAMRMC award W81XWH-05-1-0099; and ONR grants N00014-13-C-0063 and N00014-13-1-0302.

0202

EFFECT OF PARTIAL SLEEP DEPRIVATION ON EMPATHY FOR PAIN IN AN FMRI EXPERIMENT: A RELATION TO SLEEPINESS

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Introduction: Disturbed sleep affects emotional responding. It is however unknown whether disturbed sleep also affects empathy for pain. We have investigated the effect of partial sleep deprivation on empathic responding.

Methods: Predefined regions of interest were the bilateral anterior insulae and the medial cingulate cortex, which is postulated to form a core network for empathy. Healthy volunteers (n = 21, mean age 24, SD 3, 10 female) participated in a trial of partial sleep deprivation (3 h sleep) using a cross-over design, monitored by polysomnography at home. During fMRI, participants viewed pictures of hands being stung by needles or poked with a Q-tip.

Results: Across sleep conditions, pain stimuli caused significantly increased activity in the anterior insulae ($p < 0.005$) and medial cingulate cortex ($p < 0.001$), using region-of-interest analyses. In addition, whole-brain analyses showed significant activation in the left inferior parietal ($p < 0.001$) and left primary sensorimotor cortices ($p < 0.001$). Sleep deprivation caused a decrease in activity in medial cingulate cortex ($p = 0.049$) using a predefined region of interest. Higher sleepiness, as measured using the Karolinska Sleepiness Scale (after the exposure), also predicted decreased activity in medial cingulate cortex ($p = 0.035$). In bilateral insulae, sleep deprivation and self-rated sleepiness were non-significantly associated with decreased activity.

Conclusion: The results suggest that partial sleep deprivation (sleepiness) affects empathic processing in the brain.

Support (If Any): Forte.

0203

DOES IT MATTER IF YOU KNOW WHAT'S COMING? SLEEP DEPRIVATION AND ITS IMPACT ON PUPILLARY REACTIVITY TO EMOTIONAL STIMULI

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Introduction: Sleep deprivation (SD) robustly influences negative affect in non-clinical samples, including lower mood, impaired social interactions, and heightened amygdala reactivity. Short sleep duration has also been linked to mood disorders. Yet, how SD interacts with knowledge of an upcoming event's emotional content to then influence emotion processing remains unknown. Such processing can be reliably indexed by psychophysiological measurement of pupil dilation. The present study tested whether SD enhanced pupillary reactivity to (a) negative versus neutral stimuli, given (b) the expectation of negative versus neutral content.

Methods: 20 healthy young adults (aged 18-25) underwent one night each of total SD and normal sleep (NS) in a counter-balanced, within-person crossover design separated by a one-week washout. The emotion-processing task included 48 randomly presented trials of negative or neutral IAPS photos. The task consisted of 3 parts: a 6-s cue that indicated upcoming picture valence as negative or neutral or left valence unknown (25%, 25%, and 50% of trials, respectively); a 2-s picture stimulus; and an 8-s inter-stimulus interval. Pupil diameter was recorded continuously. Mixed effects models assessed diameter differences be-

tween sleep condition (SD, NS), anticipatory cue (known, unknown) and picture valence (negative, neutral).

Results: There was a significant sleep condition by valence interaction in pupillary reactivity to picture stimuli ($F = 6.77$, $p = .018$). After SD, participants were significantly more reactive to negative relative to neutral photos ($t = 2.60$, $p = .018$). Contrary to hypotheses, no interactions of anticipation with sleep condition existed ($p > .05$). Larger pupil responses, however, occurred when anticipating negative stimuli ($F = 8.42$, $p < .01$) following both NS and SD.

Conclusion: SD engendered exaggerated pupillary responses to negative stimuli, suggesting that individuals may “overreact” to negative experiences when deprived. However, no sleep-related differences resulted from anticipatory cue priming. Findings indicate that SD may induce deficits in emotional information processing that reflect increased brain reactivity to negative stimuli.

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0204

LOSS ANTICIPATION AND OUTCOME FOLLOWING TOTAL SLEEP DEPRIVATION AND NORMAL SLEEP

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Introduction: Sleep deprivation has detrimental effects on executive functions, learning, memory, and positive/negative affect. For instance, sleep deprivation can alter neural responses to reward in areas such as the caudate, amygdala, and orbital frontal cortex (OFC). Inconsistent findings have been reported on the effects of sleep deprivation and experiencing a monetary loss. Here, we compared the effects of Normal Sleep (NS) and Total Sleep Deprivation (TSD) on loss anticipation and outcome. We hypothesized that TSD would decrease activation of the caudate and OFC, and increase activation of the amygdala for both loss anticipation and loss outcome compared to NS.

Methods: Twenty-seven (Mean Age: 22.34 ± 2.68 ; 11 F) right-handed subjects were randomized to either NS ($n = 16$) or TSD ($n = 11$). Data were collected during the evening following sleep randomization using a Siemens 3T Magnetom TIM Trio scanner. All subjects completed a monetary gambling task where they could win \$10 or lose \$5 per trial. Preprocessing of the data and first-level general linear modeling analyses were completed in SPM. Second-level group analysis was used to examine loss anticipation and loss outcome in limbic and reward circuit areas by extracting ROI activation intensity values and comparing means across groups for the caudate, amygdala, and OFC.

Results: Compared to the baseline condition, loss anticipation was statistically associated with lower activation of the caudate ($p = .014$) and OFC ($p = .014$) following TSD compared to NS. Loss anticipation showed no significant between-group differences for amygdala activation. No statistically significant group differences were found for loss outcome.

Conclusion: These preliminary results suggest that TSD primarily reduces caudate and OFC responses to loss anticipation trials compared to NS. These observations have direct implications for mood and anxiety disorders, such that blunted response to losses following sleep deprivation may alter emotional responses and create a bias toward disappointing stimuli.

Support (If Any): 11293006 (PI: A. Germain, PhD).

0205

ACUTE SLEEP DEPRIVATION DECREASES INHIBITORY CAPACITY IN RELATION TO FOOD STIMULI IN HEALTHY YOUNG MEN

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Introduction: Sleep disturbances are linked to an increased risk of obesity and obesity-promoting food-related behaviors. Functional imaging suggests this is partially mediated by increased activation in reward-related brain areas coupled with loss of cognitive control in prefrontal brain areas. Furthermore, obesity is related to impulsive behavioral traits. However, no study has investigated whether acute sleep deprivation selectively impairs cognitive control in relation to food stimuli. Therefore, our aim was to investigate whether acute sleep deprivation leads to decreased cognitive control, by assessing the ability to cognitively inhibit pre-potent responses when food cues are presented during a task requiring active attention.

Methods: Fourteen males participated in the study on two separate occasions in a randomized, crossover within-subject design: One session with one night of wakefulness (total sleep deprivation, TSD); and one session with normal sleep (8.5 hours; NS). Following each nighttime intervention, participants rated hunger using visual analog scales and performed a computer-based go/no-go (GNG) task.

Results: Following TSD, participants had significantly higher hunger (7 AM: $P < 0.01$; 8 AM: $P < 0.05$) and made significantly more commission errors on the GNG task, as compared to their performance following the NS session ($25.4\% \pm 5.6$ vs. $16.3\% \pm 4.1$; $P < 0.05$). The hunger ratings did however not correlate with the commission errors and there were no significant differences in omission errors or response time between the TSD and NS conditions.

Conclusion: Acute sleep deprivation impairs cognitive control related to food stimuli in healthy young men. Similar loss of inhibition or impulsiveness has been related to obesity and could provide an additional explanation for why sleep disturbances may increase the risk of gaining weight.

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0206

LATE-NIGHT FAT INTAKE MODULATES NEXT DAY RESTING-STATE REWARD PATHWAY CONNECTIVITY DURING SLEEP DEPRIVATION

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Introduction: Insufficient sleep occurs in millions of people and sleep loss is associated with increased caloric intake and weight gain. Neuroimaging studies have suggested an important role of the dopaminergic reward system in over-consumption of food, and that sleep deprivation (SD) may alter brain responses to food stimuli in this system. However, how additional caloric intake and brain function interact during sleep loss remains unclear. In this study, we examined the relationship between late-night food intake and next day resting-state brain reward system functional connectivity (FC) during acute total SD.

Methods: Thirty-one healthy adults (14 females, ages 22-50 y) participated in a 5-day, 4-night SD study, in which they had ad libitum food/drink access. Subjects were scanned at rest three times between 7-9 am using a standard EPI sequence on a Siemens 3T MR scanner, including a SD scan after 24 h without sleep. Reward system FC analyses

were conducted using the ventral striatum (VS) as the seed region. Food/drink consumption data were collected from 25 subjects (13 females, BMI 19.7-29.6). On the night of sleep loss, macronutrient content was calculated as a percentage of caloric intake from 2230 h to 0630 h and correlated with resting brain connectivity from the SD scan.

Results: Subjects' additional caloric intake on the night of sleep loss was 816 ± 92 kcal. Macronutrient analysis showed that $30 \pm 2\%$ of the SD night caloric intake was from fat. FC analyses showed that SD significantly reduced connectivity from the VS to posterior cingulate cortex (PCC) and ventromedial prefrontal cortex (VMPFC). Moreover, late-night percentage of caloric intake from fat positively correlated with VS-VMPFC connectivity but not with VS-PCC connectivity.

Conclusion: The present study demonstrated that acute total SD was associated with impaired resting connectivity from the VS to PCC and VMPFC. The reduced VS-VMPFC connectivity after SD was modulated by additional palatable food intake during the night of sleep loss, which may reflect a natural approach to compensate for disrupted function in this reward pathway. These findings provide further evidence supporting that altered brain connectivity within the dopaminergic reward system after SD may be a key mechanism by which sleep loss alters hedonic food intake.

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0207

THE EFFECTS OF EXTENDED BEDTIMES ON SLEEP DURATION AND FOOD DESIRE IN OVERWEIGHT YOUNG ADULTS: A HOME-BASED INTERVENTION

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Introduction: Well-controlled laboratory studies have demonstrated that sleep restriction in young adults alters appetite regulation, particularly with more desire for high-calorie food, which may increase the risk for weight gain. However, the relevance of these laboratory findings to real life is uncertain. We used a home-based intervention aimed at extending bedtimes and evaluated its effects on sleep duration and food desire in at-risk individuals.

Methods: Overweight young adults (age: 21-40 years; BMI: 25.0-29.9 kg/m²) reporting average self-reported sleep duration of less than 6.5 hours were recruited. Exclusion criteria were insomnia, regular napping, shift work, extreme chronotype, recent travel across time zones, eating or psychiatric disorders, acute or chronic medical condition, alcohol abuse, smoking, pregnancy or childbirth (past year), any prescription medications, and current enrolment in diet or exercise programs. Habitual bedtimes for 1 week (baseline) were followed by bedtimes extended to 8.5 hours for 2 weeks (intervention). Participants were unaware of the intervention until after the baseline period. Participants received individualized behavioral counseling on sleep hygiene on the first day of the intervention period. Sleep duration was continuously measured by actigraphy. Participants completed visual analog scales of vigor and appetite after baseline and intervention periods.

Results: Participants (n = 10) had a mean age of 28.6 years and mean BMI of 28.0 kg/m². Bedtime duration was increased by 1.8 hours with the intervention (6.4 vs. 8.2, $p < 0.001$). Sleep efficiency and latency were similar during both study periods. On average, participants obtained 1.6 hours more sleep with extended bedtimes (5.6 vs. 7.1; $p < 0.001$) and reported being less sleepy ($p = 0.004$) and more vigorous ($p = 0.034$). Sleep duration increased by an average of 1.4 hours on weekday nights and 1.9 hours on weekend nights. Additional sleep was associated

with 14% decrease in overall appetite ($p = 0.030$) and 62% decrease in sweet and salty foods ($p = 0.017$). Desire for fruits, vegetables and protein-rich nutrients was not affected by added sleep.

Conclusion: Sleep duration can be successfully increased in real life conditions and obtaining adequate sleep increases vigor and decreases cravings for weight promoting sweet and salty foods in overweight young adults who habitually curtail their sleep. This is the first demonstration that sleep extension is feasible and has beneficial effects in real life settings where individuals have priorities and other responsibilities competing with sleep.

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0208

MONOCYTE SENSITIVITY TO GLUCOCORTICOIDS IN RESPONSE TO PATTERNS OF REPEATED SLEEP RESTRICTION AND RECOVERY

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Introduction: Patterns of insufficient sleep on weekdays followed by recovery sleep on weekends are highly prevalent in working populations. It has been shown that the sensitivity of cells (e.g. monocytes) to the counter-inflammatory hormone glucocorticoid (GC) diminishes in response to an acute stressor. We investigated whether the increased inflammatory state previously observed in models of insufficient sleep is due to a decrease in GC sensitivity of monocytes.

Methods: Ten healthy young subjects (age 25 ± 1.2 yrs, 5 women) completed two 25 day in-hospital periods; sleep restriction (SR) and control sleep in randomized order. The SR condition consisted of three cycles of five days with 4 h of sleep/night followed by two days with 8 h of sleep/night. Blood draws were taken at 11:30 h on the baseline day, the fifth day of each sleep restriction cycle, and the second day of each recovery sleep period. GC sensitivity of monocytes was determined by measuring the ability of dexamethasone (DEX) to suppress lipopolysaccharide (LPS)-stimulated interleukin 6 (IL-6) expression in monocytes.

Results: IL-6 expression in stimulated monocytes was higher in the second cycle of SR compared to control sleep ($42 \pm 6\%$ vs. $25 \pm 6\%$ expression, $p < 0.05$) and showed a trend towards elevated expression in the third SR cycle ($39 \pm 7\%$ vs. $25 \pm 9\%$, $p = 0.06$). GC sensitivity of monocytes was increased during the second SR cycle compared to control sleep (indicated by increased IL-6 suppression by DEX: $-24 \pm 4\%$ vs. $-11 \pm 2\%$, $p < 0.05$) as well as during the third sleep restriction cycle ($-16 \pm 2\%$ vs. $-8 \pm 2\%$, $p < 0.05$). GC sensitivity of monocytes was still higher after recovery sleep following the third sleep restriction cycle (IL-6 suppression: $-18 \pm 3\%$ vs. $-11 \pm 3\%$, $p = 0.06$).

Conclusion: These preliminary data show that despite an increase in the sensitivity of monocytes to the counter-inflammatory GC signal, monocytes still express more IL-6 in response to repeated patterns of sleep restriction and recovery.

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0209

SLEEP DEPRIVATION RESULTS IN OXIDATIVE DNA DAMAGE: A DISEASE RISK FACTOR

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Introduction: Sleep deficiency results in increased cell injury markers, such as cytokines, heat shock proteins, and imbalances between oxidants and antioxidants in peripheral tissues. However, cell injury per se has not been revealed. The purpose of the present study was to discover physical evidence of cell injury that could be inferred from the presence of systemic markers.

Methods: Partial (35% sleep reduction) and near total sleep deprivation were produced in rats by the Bergmann-Rechtschaffen method for 10 days; this duration is tolerated and produces few outward signs besides hyperphagia. Control rats were studied under the same experimental conditions but allowed consolidated sleep. Recovery rats were sleep deprived for 10 days and then allowed undisturbed sleep for 2 days. The plasma, liver, lung, intestine, heart and spleen were studied. Concentrations of the following were measured: 8-hydroxydeoxyguanosine (8-OHdG), which is an oxidized DNA base; carbonyl group formation and nitrotyrosine, which are markers of protein damage; and plasma isoprostane, which is a systemic marker of lipid peroxidation. Values were analyzed on a logarithmic scale by linear regression with random animal effects, followed by pair-wise comparisons among treatment groups adjusted for multiple comparisons.

Results: Comparisons with control values are as follows. Overall 8-OHdG concentrations were increased by 27% and 39% in partially and totally sleep-deprived rats, respectively ($P = 0.0002$ and $P < 0.0001$). Organ-specific 8-OHdG values were increased by 147% in the liver, 45% in the intestine, and 66% in the lung of totally sleep-deprived rats ($P < 0.003$), and by 67% in the liver and 77% in the lung in partially sleep-deprived rats ($P < 0.006$). Nitrotyrosine was increased only in the spleens by 134% and 173% in partial and total sleep deprivation ($P = 0.05$ and $P = 0.021$), respectively. Changes in carbonyls and lipid peroxidation were not significant during partial or total sleep deprivation. Recovery sleep decreased lipid peroxidation by 31% in sleep-deprived rats ($P = 0.039$) and reversed sleep deprivation effects in both groups.

Conclusion: The outcomes indicate that sleep deprivation results in cell injury. Profound increases in oxidative DNA damage reflect either compromised repair mechanisms or insufficient repair for an increased rate of damage. Cell injury is expected to underlie disease risk from disrupted sleep shown by epidemiological studies. Imbalances reversed by recovery sleep point to cellular pathways involved in restorative properties of sleep.

Support (If Any): National Heart, Lung and Blood Institute, National Center for Advancing Translational Sciences.

0210

EARLY BEDTIMES REDUCE 24-HR INTAKE FOR ADOLESCENTS WITH EARLY CHRONOTYPES, BUT NOT THOSE WITH LATE CHRONOTYPESBeebe DW¹, Rausch J¹, Zhou A², Noe O³, Simon S⁴¹Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA,²University of Cincinnati College of Medicine, Cincinnati, OH, USA,³Boston College, Boston, MA, USA, ⁴University of Colorado School of Medicine, Denver, CO, USA

Introduction: We previously reported experimentally shortened sleep increases caloric intake in healthy adolescents. We collected additional data and here examine whether setting an early bedtime has a protective effect for both teens with earlier chronotypes ("morning larks") and those with later chronotypes ("night owls").

Methods: Seventy-three typically-developing teens aged 14-17 underwent a 3-week within-subject protocol: a baseline week followed by 2 randomly counterbalanced experimental weeks. Wake time was held constant. Bedtime was self-selected during the baseline condition, set late during sleep restriction (SR; 6.5 hours in bed) and set early during healthy sleep (HS; 10 hours in bed). Sleep was monitored via actigraphy. Actigraphy-determined midsleep time during the baseline was used to estimate chronotype as a continuous variable, and correlated with the midpoint of self-reported habitual school night and weekend sleep, $p < .005$. Teens completed validated 24-hour dietary recall interviews at the end of 5 nights each of HS and SR. Linear mixed modeling looked for differences in the slope in cumulative caloric intake across the day as a function of condition and chronotype.

Results: Teens fell asleep 2.5 hours earlier during HS (10:13 pm) than SR (12:42 am), $p < .0001$, but had near-identical rise times (7:10 vs. 7:11 am). The main effect of sleep condition on caloric intake was significantly moderated by chronotype, $p = .01$, and remained so after covarying for age, sex, and race. During SR, chronotype made little difference in intake patterns. HS appeared protective in teens with earlier chronotypes, reducing their afternoon and evening eating, but had little effect on teens with later chronotypes.

Conclusion: While SR may broadly increase dietary intake, setting early bedtimes appears to be protective only among teens whose "internal clock" is set to prefer earlier bed- and rise-times. Future research is needed to determine if later rise times could reduce the dietary intake of "night owls."

Support (If Any): NIH (R01-HL092149, UL1-TR000077).

0211

THE RELATIONSHIP BETWEEN SLEEP DURATION AND CARDIOMETABOLIC RISK FACTORS DEPENDS ON RACE/ETHNICITY AND WHETHER RISK FACTORS WERE SELF-REPORTED OR OBJECTIVELY-DETERMINEDGrandner MA¹, Chakravorty S², Perlis M², Oliver L², Gurubhagavatula I²¹Psychiatry, University of Pennsylvania, Philadelphia, PA, USA,²University of Pennsylvania, Philadelphia, PA, USA

Introduction: Sleep duration is associated with cardiometabolic disease risk factors including hypertension, hyperlipidemia, diabetes and obesity. Not only are short and long sleep duration disproportionately experienced among race/ethnicity groups, but these cardiometabolic risks are as well. It is possible that the relationship between cardiometabolic disease and sleep depends on race/ethnicity. Also, this may depend on whether cardiometabolic risk is self-reported vs objectively-determined.

Methods: We analyzed adult 2007-2008 National Health and Nutrition Examination Survey (NHANES) data ($N = 5,649$). Average self-reported nightly sleep duration was reported and categorized as either ≤ 4 h, 5-6 h, 7-8 h, or ≥ 9 h. Self-reported as well as objectively-determined obesity, diabetes, hypertension, and hyperlipidemia were recorded. Binary logistic regression analyses, stratified by race/ethnicity, were performed using cardiometabolic factor as the outcome variable, and sleep duration category as the predictor variable, after adjusting for age, sex, acculturation, education, access to insurance, food security, home ownership, smoking and caffeine use.

Results: Significant sleep*race/ethnicity interactions existed for all cardiometabolic outcomes using both measurement approaches (all $p < 0.005$). Among non-Hispanic Whites, ≤ 4 h was associated with self-reported hypertension (OR = 1.91; 95%CI [1.18, 3.09]; $p = 0.009$), hyperlipidemia (OR = 2.10; 95%CI [1.33, 3.32]; $p = 0.002$), and diabetes (OR = 2.40; 95%CI [1.27, 4.52]; $p = 0.007$), and objectively-determined hyperlipidemia (OR = 1.62; 95%CI [1.03, 2.54]; $p = 0.035$), and ≥ 9 h was associated with objectively-determined hyperlipidemia (OR = 1.55;

95%CI [1.07, 2.25]; $p = 0.020$). Among Blacks/African-Americans, ≤ 4 h was associated with self-reported hypertension (OR = 2.12; 95%CI [1.25, 3.61]; $p = 0.005$) and obesity (OR = 1.91; 95%CI [1.20, 3.05]; $p = 0.007$). Among Mexican-Americans, 5-6 h was associated with self-reported hypertension (OR = 1.93; 95%CI [1.25, 2.96]; $p = 0.003$) and obesity (OR = 1.45; 95%CI [1.04, 2.04]; $p = 0.030$) and ≥ 9 h was associated with less self-reported hyperlipidemia (OR = 0.41; 95%CI [0.20, 0.85]; $p = 0.016$). Among other Hispanics/Latinos, ≤ 4 h was associated with self-reported (OR = 3.53; 95%CI [1.50, 8.29]; $p = 0.004$) and objectively-determined (OR = 2.86; 95%CI [1.21, 6.73]; $p = 0.016$) hypertension and 5-6 h was associated with less objectively-determined diabetes (OR = 0.45; 95%CI [0.23, 0.89]; $p = 0.022$). Among Asians/Others, ≤ 4 h was associated with self-reported (OR = 11.50; 95%CI [2.30, 59.10]; $p = 0.003$) and objectively-determined (OR = 3.74; 95%CI [1.16, 12.03]; $p = 0.027$) hyperlipidemia.

Conclusion: The relationship between sleep duration and cardiometabolic risk factors depended on race ethnicity for each risk factor assessed, though the patterns differed. Also, whether hypertension, hyperlipidemia, diabetes and obesity were assessed via self-report or by objective measures dictated results in some cases. Future studies should carefully consider these factors in determining individual and population-level risk.

Support (If Any): K23HL110216, R21ES022931, UL1RR024134.

0212

SLEEP DURATION AND SOCIAL DEPRIVATION IN TWINS

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Introduction: The Singh Index (SI) is a composite, area-level measure of social deprivation. We sought to investigate the relationship between sleep duration and SI in a genetically informative twin sample.

Methods: Sleep duration was ascertained by the question, "on average, how long do you sleep per night?" The SI was constructed from 17 Census-based socioeconomic measures chosen through factor analysis. Structural equation models established the genetic and environmental contributions to SI and sleep duration and controlled for correlations from overlapping genetic or environmental influences.

Results: Participants were 2,202 twin pairs [1,268 monozygotic pairs, 934 dizygotic pairs], 62.1% female, with mean age 37.4 years (SD = 17.2; range = 18.0, 94.6 years) from the University of Washington Twin Registry. Mean sleep duration was 7.4 hours (SD = 1.2; range = 2.0, 13.8), and mean SI was -0.2 (SD = 0.8; range = -2.7, 4.1). The heritability of sleep duration was 34% and SI 28%. Singh Index had a modest contribution from the shared (family) environment (29%) with the balance due to unique environment factors (43%), while sleep duration had no shared environmental but large unique environmental influences (66%). Singh Index was significantly associated with sleep duration across all twins ($b = -0.096$, $p < .001$) such that increases in SI, indicating increased social deprivation, were associated with decreased sleep duration. Controlling for genetic-based selection by assessing the relationship within twin pairs, the SI remained significantly associated with sleep duration ($b = -.122$, $p = .016$). The within-pair association indicates this relationship is robust, and present after accounting for genetic and familial confounding.

Conclusion: Singh index was associated with sleep duration across all twins and in the within-pair analysis. This work indicates ecological factors such as social deprivation may be important determinants of habitual sleep duration, irrespective of genetic and familial influences.

Support (If Any): K23HL083350 and 1P30NR011400.

0213

MITOCHONDRIAL DNA COPY NUMBER IN SLEEP DURATION DISCORDANT MONOZYGOTIC TWINS

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Introduction: Mitochondrial DNA (mtDNA) is a crucial aspect of mitochondrial function and can vary with age, disease, and environmental factors. The relationship between mtDNA and sleep duration has not been previously studied. Therefore, we investigated mtDNA copy number in monozygotic twins discordant for actigraphically phenotyped habitual sleep duration.

Methods: Fifteen monozygotic twin pairs (80% female; mean age 42.1 years; SD = 15.0), selected based on subjective sleep duration discordance, were phenotyped for sleep duration with two-weeks of wrist actigraphy. We used a standard actigraphy scoring algorithm to calculate 24 hour sleep durations. Each twin pair included a "normal" (7-9 hours duration) and "short" (< 7 hours duration) sleeping twin. Fasting peripheral blood leukocyte (PBL) DNA was obtained on the final day of actigraphy and assessed for mtDNA copy number via the n-fold difference between qPCR measured mtDNA and nuclear diploid DNA. We used generalized estimating equation linear regression models accounting for the correlated data structure to assess within- and between-pair effects of sleep duration on mtDNA copy number. Covariates including age, gender, race, and body mass index were included in the model.

Results: Mean within-pair sleep duration difference per 24 hours was 94.3 minutes (SD = 62.6 minutes; range 45.9, 300.3 minutes). We found a significant overall effect of sleep duration on PBL mtDNA copy number ($\beta = 0.06$; 95% CI 0.0004, 0.1217; $p < 0.05$) such that reducing sleep duration was associated with reduced PBL mtDNA copy number. This effect was not observed within-twin pairs ($\beta = 0.02$; 95% CI -0.009, 0.046; $p = 0.19$) suggesting the overall effect was influenced by familial factors.

Conclusion: Reducing sleep duration was associated with reduced mtDNA copy number. This suggests short sleep related free radical damage to mtDNA compromises metabolic function and reduces metabolic efficiency with potential implications for health and longevity.

0214

SEASONAL CHANGES OF PERFORMANCE IN DIFFERENT NATURAL DAYLIGHT CONDITIONS AMONG SHIFT WORKERS LIVING IN NORTHERN REGION

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Introduction: Shift work is very common among medical staff. Misalignment of biological clocks due to shift work can lead to fatigue, sleep loss, and excessive sleepiness. The daylight length changes seasonally in 3.5 times on 61st latitude in Northern region so it may have effect on body clocks. The aim of the current study was to determine sleep and performance of shift workers in natural seasonal conditions.

Methods: 136 healthcare workers participated in the study during in 2 weeks periods around winter (daylight length 5 h 33 min) and summer solstice (daylight length 19 h 19 min). There were 53 men (mean age 32.4±6.2 years) and 83 women (mean age 36.8±7.7 years) who worked 24 h shifts (79 people) with 48 h rest; 12 h shifts with 36 h rest period (36 people) and control group 8 h daily work (21 people). Sleep quality was determined using the Russian sleep characteristics questionnaire. Sleepiness was measured by Epworth Sleepiness Scale. Melatonin levels were assessed by 6-sulfatoxymelatonin (a6MT) in the morning urine samples before and after night shift. Psychomotor performance was measured by the M.P. Moroz method "Express diagnostics of performance and functional status of human" in the beginning and in the end of shifts with assessment of Mean Response Time. Data were analyzed using repeated measures ANOVA.

Results: Daily sleepiness by the Epworth Questionnaire was in normal range in all groups. Changes in the sleep quality were only in daily workers from 17.4±2.0 in winter to 21.4±3.6 ($p = 0.04$) in summer (pathological is < 19). A6MT level was higher in all groups in winter than in summer and showed increase significantly after shift in summer in 12 h group. A6MT level correlated with Mean Response Time.

Conclusion: Our results showed seasonal changes in sleep quality for daily workers with worse scores in short day length period. Natural changes in daylight conditions may have effect to performance in shift workers by suppression of melatonin that improve psychomotor performance.

0215

SHIFTWORK PRACTICES IN THE UNITED STATES NAVY: A STUDY OF SLEEP AND PERFORMANCE IN WATCHSTANDERS ABOARD THE USS JASON DUNHAM

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Introduction: It is well established that members of the military get inadequate sleep. Shay (1998) traced sleep deprivation in the military back to the ancient Greeks. Kleitman (1963) reported the poor sleep practices of Navy submariners dating to the 1950s. Unfortunately, all branches of the military have a tradition of sacrificing sleep and the problem has only been exacerbated by the 24/7 nature of continuous operations in the current defense climate. Despite efforts to address sleep deprivation in the military, it still poses a serious threat to safety and operational effectiveness. Sailors in the United States Navy are habitual shiftworkers, often working shifts that result in circadian misalignment equating to an 18 or 20-hour day without weekends or time for recovery. Working other than a 24-hour day, especially shorter days that impose a type of chronic jet-lag, is a well-known contributor to fatigue in the civilian shiftwork population. We proposed the adoption of a 3-on/9-off circadian-aligned

watchstanding schedule based on a 4-section watchbill where sailors stand 3-hour watches that commence every 12 hours.

Methods: As part of a larger data collection on 122 crewmembers, 33 U.S. Navy sailors participated in a two-week study of two work/rest schedules in an operational environment. The alternative watchstanding schedule ("3/9") involved standing 3 hours of watch followed by 9 hours off watch. The standard schedule ("6/6") consisted of standing 6 hours of watch followed by 6 hours off watch. Each sailor wore an actigraph, completed a daily sleep and activity log, and performed a 3-minute psychomotor vigilance test before and after standing watch.

Results: This preliminary analysis focused on sailors' sleep patterns. A mixed-effects ANOVA was used to examine the effects of watchstanding schedule and day on total sleep time per 24-hour period. Sailors working the alternative watchstanding schedule received an average of 86 minutes more sleep compared to their counterparts working the standard 6/6 schedule ($F_{1,302} = 22.06$; $p < 0.001$). The interaction between watchstanding schedule and day of the study was also statistically significant ($F_{11,302} = 2.17$; $p = 0.02$).

Conclusion: Preliminary results indicate sailors working an alternative watchstanding schedule get more sleep than those on a standard schedule. Additional sleep gained using this alternative schedule may have direct impact on sailors' performance within the surface Navy community.

Support (If Any): This study was supported by the United States Navy Bureau of Medicine, United States Navy N171, and the Office of Naval Research.

0216

FIGHTING FIRES AND FATIGUE: EFFECT OF 4-HOURS SLEEP DEPRIVATION ON FIREFIGHTER PHYSICAL PERFORMANCE DURING SIMULATED BUSHFIRE SUPPRESSION

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Introduction: To curtail the spread of bushfire, Australia's firefighters regularly work for 2-5 consecutive days obtaining on average 3-4 hours' sleep per night. The inherent dangers faced by firefighters require optimal levels of physical and cognitive functioning to ensure the safety of themselves and those they protect. While the effects of sleep restriction on cognitive function are well established, less is known about the effect on physical work performance. Therefore, the aim of this study was to determine the effect of sleep restriction on firefighter physical work performance during simulated multi-day bushfire suppression.

Methods: Thirty-five firefighters were randomly allocated to either the control group (8-hour sleep opportunity, $n = 18$) or the sleep restricted group (4-hour sleep opportunity, $n = 17$) and asked to perform simulated firefighting activities across two days. Self-paced physical performance was evaluated during a 55-min circuit comprising of six key firefighting tasks. After each task, participants reported their rate of perceived exertion and motivation. Heart rate and energy expenditure was measured continuously. Sleep was monitored by polysomnography. A general linear mixed modelling approach was used for analyses.

Results: Preliminary results indicate that there were no significant deleterious effects of sleep restriction on firefighters' physical performance, heart rate, or perceptual responses during self-paced simulated firefighting work tasks, compared to the control group. However, the sleep restricted group expended less energy during periods of rest compared to the control group as evidenced by lower activity counts and heart rate.

Conclusion: Under self-paced work conditions, sleep restricted individuals preferentially selected to conserve effort during periods when movement was inessential to task completion. This may have aided

sleep restricted participants in maintaining similar standards to the control participants when physical task performance was then required. This work will assist fire agencies in defining the physical capabilities of fire-fighters who have had limited sleep and provide guidelines on timing and frequency of rest periods.

0217

IMPACT OF HIGH DOSE CAFFEINE ON DAYTIME RECOVERY SLEEP FOLLOWING SLEEP DEPRIVATION

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Introduction: Caffeine is a common fatigue countermeasure particularly in sustained operations. Although a number of studies have investigated the effect of caffeine on recovery sleep, few have assessed the impact on daytime recovery sleep. This study investigated the impact of high caffeine consumption on daytime recovery sleep following 49 h wakefulness.

Methods: Preliminary analyses were conducted on 11 out of N = 24 young adults. Participants were randomly assigned to either a caffeine (n = 7, 4F, 22.4 ± 1.7 yr, 21.8 ± 1.7 kg/m²) or placebo condition (n = 4, 2F, 20.6 ± 2.5 yr, 20.6 ± 2.5 kg/m²). Participants were scheduled to one baseline sleep (22:00-08:00 h, 10 h TIB) followed by two nights (49 h) of wakefulness. Each night at 01:00 h, 03:00 h, 05:00 h and 07:00 h participants were given 200 mg of caffeine or placebo gum. Participants were then scheduled to a daytime recovery sleep (10:00-19:00 h, 9 h TIB). Sleep was recorded using standard polysomnography and scored according to Rechtschaffen and Kales guidelines by an experienced technician blind to condition. To assess the effect of caffeine on daytime recovery sleep, data were analysed with between groups ANOVA.

Results: Results indicate that TST (F[1,9] = 0.66, p = 0.44), sleep efficiency (F[1,9] = 0.04, p = 0.85), sleep onset latency (F[1,9] = 3.40, p = 0.10) and stage 2 sleep (F[1,9] = 0.64, p = 0.44) were not significantly different between the caffeine and placebo conditions. SWS (F[1,9] = 12.56, p < 0.01) and REM sleep (F[1,9] = 5.60, p < 0.05) did significantly differ between the two conditions, with lower amounts of SWS observed in the caffeine condition (109.7 ± 24.7 min) compared to the placebo condition (157.6 ± 13.2 min) and higher amounts of REM sleep observed in the caffeine condition (135.4 ± 27.5 min) compared to placebo (95.0 ± 26.7 min).

Conclusion: Preliminary results demonstrate that after 49 h of sustained wakefulness caffeine affects the composition of daytime recovery sleep, by increasing REM sleep and decreasing SWS, but not the duration or consolidation of recovery sleep. Future analyses will compare the effect of caffeine on daytime recovery sleep to nocturnal baseline sleep.

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0218

EXPLORING MEDIATORS OF THE RELATIONSHIP BETWEEN SLEEP DURATION AND BODY MASS INDEX

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Introduction: Although the relationship between sleep duration and body mass index (BMI) has been well-characterized, the underlying mechanisms have not. Understanding which factors explain this relationship would provide important insights in developing effective public health interventions to reduce associated cardiometabolic risks. The present study investigated 5 potential mediators of the relationship between sleep duration and BMI.

Methods: Data from the 2009 Behavioral Risk Factor Surveillance System (BRFSS) was used in our analysis. BRFSS is a CDC-sponsored project representing the world's largest ongoing, state-specific, randomized telephone survey that measures behavioral risk factors among U.S. adults [mean age = 56 ± 16 years, female = 63%]. Analysis focused on interviews conducted in six representative states, soliciting sociodemographic, medical, sleep, and health-risk data, yielding observations for n = 35,895 respondents. A bootstrapping method was employed to generate confidence intervals (BCCI) ascertaining total and unique mediation across all 5 hypothesized mediators simultaneously (using 1,000 bootstrap samples) of the sleep duration and BMI relationship. The hypothesized mediators included: alcohol use, diet, physical activity, general health status, and life satisfaction. Age and sex were adjusted in all tested models.

Results: Analysis showed that for each additional hour of sleep BMI decreases by 0.15 unit. Evidence of unique mediation was noted for: physical activity (BCCI = 0.0017 to 0.0102; SE = 0.0022), diet (BCCI = -0.0138 to -0.0052; SE = 0.0022), and general health status (BCCI = -0.0379 to -0.0079; SE = 0.0423). However, there was no evidence of unique mediation for: alcohol use (BCCI = -0.0013 to 0.0019; SE = 0.0008) or life satisfaction (BCCI = -0.0057 to 0.0057; SE = 0.0028).

Conclusion: These findings suggest that the sleep and BMI relationship may be partially mediated by physical activity, diet, and general health. This is consistent with previous hypotheses regarding the role of lifestyle. Interventions targeting these factors may be particularly useful.

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0219

ACUTE SLEEP RESTRICTION EFFECTS ON DIETARY INTAKE IN PRESCHOOL CHILDREN

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Introduction: Epidemiological findings suggest short sleep duration is associated with overweight/obesity across the lifespan. In adults, ex-

perimental sleep restriction increases caloric intake more than total daily energy needs, leading to weight gain. Little is known about the relationship between acute sleep restriction and dietary intake in preschoolers.

Methods: Children ($n = 7$; 30-48 months; 4 females) completed a randomized, counter-balanced study, including a strict biphasic sleep schedule for 5 days before each of 2 experimenter-monitored conditions: Baseline (afternoon nap and regular bedtime) and Sleep Restriction (no nap and 3 h bedtime delay). Sleep was quantified via wrist actigraphy. Parents tracked children's food intake with logs and completed an on-line, experimenter-mediated 24-hour dietary recall for the Baseline and Sleep Restriction days. Total kilocalories and grams of fat, sugar, carbohydrates, and protein were computed. Sleep and dietary intake measures were compared between conditions with paired t-tests.

Results: Children slept similar amounts on nights prior to dietary assessments (Baseline 601 ± 51 min, Sleep Restriction 599 ± 24 min; $p = 0.94$). Total wake time was 211 ± 88 min greater ($p = 0.001$) on the Sleep Restriction than the Baseline day. Compared with Baseline, children consumed 254.4 ± 138.3 more kcal (19%; $p < 0.001$, $d = 0.92$), 16.8 ± 11.3 more grams of sugar (17%; $p = 0.004$, $d = 0.60$), 7.2 ± 9.0 more grams of fat (16%; $p = 0.04$, $d = 0.57$), and 11.8 ± 8.1 more grams of protein (24%; $p = 0.005$, $d = 1.09$) on the day of Sleep Restriction. No difference in carbohydrate intake was observed.

Conclusion: Our preliminary experimental findings suggest that missing a nap and going to bed late increases food intake in preschoolers. Results are consistent with prior epidemiologic studies and may help to explain mechanistic associations between short sleep and obesity in children, as well as increased risk of weight gain over time. Future research quantifying the nature of the associations among sleep restriction, food intake, positive energy balance, and weight gain in young children is warranted.

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0220

CORRELATION OF OBJECTIVE AND SUBJECTIVE PAIN SENSITIVITIES UNDER SLEEP RESTRICTION

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Introduction: It has been reported that pain sensitivity (i.e., activity of the brain neurons) are closely related to sleep quality. In this pilot study, we aim to quantify subjective and objective pain sensitivity, and explore their correlation.

Methods: Healthy controls ($n = 25$; all male; age 28.4 ± 4.3 , BMI 22.6 ± 2.2) were housed at a sleep center for two nights: one for baseline and one, after a week, for sleep restriction (with 2 hours bedding time). In the following morning, resting EEGs (500 Hz, Cz) without and with acute pain (electric and capsaicin) was recorded. Subjective pain sensitivity and tolerance were reported. Power spectra were calculated for quantitative EEG analysis. Paired t-test and Pearson's correlation were performed to find statistical significances.

Results: Under sleep restriction, subjective pain sensitivity increased (6.4 ± 2.1 vs. 5.5 ± 1.4 , $p < 0.01$), while pain tolerance decreased (40.5 ± 16.1 vs. 52.3 ± 12.0 , $p < 0.01$). Regardless of stimuli, sleep restriction reduced the alpha rhythm (in %) significantly (22.8 ± 3.0 vs. 35.0 ± 3.2 without stimuli; 26.0 ± 3.3 vs. 35.0 ± 3.3 with electric stimuli; 25.2 ± 3.1 vs. 39.8 ± 3.2 with capsaicin). Stimuli (especially capsaicin) enhanced

the alpha significantly at the baseline ($p < 0.01$). However, these enhancements were not observed under sleep restriction. The reduced subjective pain tolerance was correlated to the changes in the alpha under sleep restriction ($r = -0.441$, $p = 0.04$).

Conclusion: This pilot study showed the EEG alpha rhythm could be a potential biomarker to quantify pain sensitivity and tolerance under sleep restriction.

Support (If Any): This work was supported by the MEST and KOFST.

0221

EFFECT OF SLEEP RESTRICTION ON CORTISOL CONCENTRATION DURING SIMULATED PHYSICAL FIREFIGHTING WORK

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Introduction: Sleep restriction and physical work are two stressors faced by firefighters, yet the combined impact of these demands on firefighters' acute hormonal responses is poorly understood. The aim of this study was to assess the effect restricted sleep has on firefighters cortisol levels during a simulated three-day and two-night fireground deployment.

Methods: Firefighters completed multiple days of simulated physical work separated by either an 8-h or (i.e., Control group; bedtime 22.00-06.00; 15 men; 3 women; 39 ± 16 yr) or 4-h sleep opportunity (bedtime 0200-0600; 15 men; 2 women; 39 ± 15 yr) between days. Participants completed multiple work circuits each day, comprising firefighting tasks that simulated the physical demands of firefighting. Salivary cortisol was sampled every 2-h each day in both conditions at identical time points. Linear mixed models were used for the analysis.

Results: Cortisol concentration was significantly different between conditions, with the sleep restriction condition demonstrating greater morning cortisol levels on days two and three compared to control. Furthermore, cortisol concentration at all time points on day three was greater among participants in the sleep restriction condition.

Conclusion: Multiple days of firefighting work separated by restricted sleep opportunities were associated with elevated cortisol levels. On day three, cortisol levels in the sleep restriction condition exceeded the normal reference ranges for adults at most time points. Given the negative health implications persistently elevated cortisol can have, these findings suggest that agencies should, wherever possible ensure their personnel receive an 8-h sleep opportunity between shifts. Future research should focus on what impact chronic exposure (e.g., over a career) to these demands may have on the health of personnel. Additionally, this research provides insights and a basis for further investigation among other industries (e.g., police, mining) with similar sleep and physical work demands to firefighting.

0222

LACK OF SLEEP DURING COMBAT DEPLOYMENT IS ASSOCIATED WITH REDUCED MISSION PERFORMANCE

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Introduction: Military service members on combat deployments consistently report sleeping less than the optimal eight hours per night. Several factors contribute to this lack of sleep during deployment including high operational tempo, combat stress, poor sleep environment, and night operations. The effects of chronic sleep restriction are widespread and include impaired cognition, which could have an impact on the successful completion of combat operations. The purpose of this study was

to examine the link between self-reported average nightly sleep duration during deployment and the incidence of accidents or mistakes that affected a mission.

Methods: Anonymous survey data were collected from randomly selected U.S. combat platoons deployed to Afghanistan during Mental Health Advisory Team (MHAT) surveillance missions. MHAT survey data used in this analysis included questions about demographics, deployment experience, average number of hours of sleep per day, sleep disruption, accidents or mistakes associated with sleepiness, and stress related to deployment and other life experiences. Survey data were analyzed using Chi-square tests, correlation analysis, and logistic regression.

Results: On average, service members reported getting less than six hours of sleep per day during deployment. There was a significant negative correlation between the number of hours of sleep reported per day and the incidence of accidents or mistakes that affected the mission. A logistic regression revealed that less sleep was associated with more accidents or mistakes when controlling for rank, months deployed, and stress variables.

Conclusion: Chronic sleep restriction is common among U.S. service members during combat deployments. The less sleep a service member gets, the more likely they are to have an accident or make a mistake that affects their combat mission. The lack of sufficient undisturbed sleep in combat environments is due to several factors, some of which may be mitigated through training and education for junior service members and leaders.

0223

EXPLORING THE INFLUENCE OF SLEEP DEPRIVATION, SHIFT WORK, AND HEAT EXPOSURE ON ALERTNESS IN UNDERGROUND MINERS

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Introduction: The extent to which an underground miner's alertness is influenced by an interaction between sleep deprivation, shift work, and working in elevated temperatures is unknown.

Methods: Eighteen underground miners participated in up to 30 consecutive days of data collection, an entire rotating shift including day and night shifts as well as days off. Actigraphy data was collected for the duration of the study. Participants also completed a sleep log and as many as four 3-minute psychomotor vigilance tasks daily. In addition, core body temperature (CBT) data was gathered from participants during four regularly scheduled shifts, two day shifts and two night shifts.

Results: Participants experienced shortened sleep periods and poor sleep efficiency ($\leq 85\%$) prior to beginning a shift. Total sleep time before day shifts (319.8 ± 47.2 mins) was significantly shorter than during days off (369.8 ± 64.1 mins, $p = 0.004$). Significant increases in reaction time (RT) and attentional lapses occurred over the course of night shifts ($p = 0.006$ and $p = 0.018$), a decline in performance not observed during day shifts. Reaction times were significantly slower after a night shift (351.6 ± 57.9 ms) than after a day shift (327.4 ± 50.3 ms; $p = 0.012$). A strong, negative correlation between CBT and RT was present throughout day shifts ($p = 0.001$) but did not appear during night shifts ($p > 0.05$).

Conclusion: Poor sleep and altered circadian rhythms appear to negatively affect the alertness of participants during work times. The increases in RT observed during night shifts suggest an inability to maintain levels of performance, possibly resulting from the extended wake time accumulated prior to night shifts. Another contributor to poor nighttime performance may be inadequate adaptation to night work schedules indicated by the absence of a relationship between CBT and alertness during night shifts.

Support (If Any): This research was supported by a grant from the Ontario Workplace Safety and Insurance Board (WSIB).

0224

LAPAROSCOPIC SKILLS AND COGNITIVE FUNCTION ARE NOT AFFECTED IN SURGEONS DURING A NIGHT SHIFT

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Introduction: Surgeons' psychomotor and cognitive skills are, due to sleep deprivation, worse post call than pre call. However, data on how surgeons perform during night shifts are lacking. The aim of this study was to monitor surgeons' performance and cognition during night shifts.

Methods: The surgeons were monitored pre call and on call (17-hour shift). Psychomotor performance was assessed by laparoscopic simulation and cognition by the d2-test of attention. The surgeons performed the laparoscopic simulation and the d2-test of attention at 08:00 hours pre call and at 04:00 hours on call. Sleep was measured by wrist actigraphy and sleepiness by the Karolinska Sleepiness Scale (KSS).

Results: Thirty surgeons were included. However, one surgeon was subsequently excluded, due to myxedema. The surgeons slept significantly less on call (median(iqr) 51(32-152) minutes) than pre call (390(358-419) minutes). Additionally, there was increasing sleepiness on call measured by KSS with a median plateau from 04:00 to 08:00 hours at score 7 (sleepy but not fighting sleep). However, no significant differences were found in any of the pre call laparoscopic simulation values compared with on call values (time of simulation, blood loss, instrument angular path and instrument path length). The d2 test of attention showed significantly improved values on call compared with pre call.

Conclusion: Sleep deprivation during a 17-hour night shift did not impair surgeons' psychomotor or cognitive performance. The study supports a working schedule of 16-24 hour shifts for surgeons, but without staying for clinical duties the day after a night call.

Support (If Any): The study was financially supported by The Tryg Foundation and The Danish Medical Association.

0225

DECREASED HEART RATE VARIABILITY IN SURGEONS DURING NIGHT SHIFTS

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Introduction: Heart rate variability (HRV) has been used as a measure of stress and mental strain in surgeons. Low HRV has been associated with death and increased risk of cardiac events in the general population. The aim of this study was to clarify the effect of a 17-hour night shift on surgeons' HRV.

Methods: Surgeons were monitored prospectively with an ambulatory ECG device for 48 consecutive hours, on a pre call and on call day (17-hour shift). HRV was measured by frequency domain parameters. An increase in the power of High frequency (HF) was used as a measure of increase in parasympathetic activity and equally an increase in Low Frequency (LF) was used as a measure of increase in sympathetic activity. The LF/HF ratio was used as an index of the sympathovagal balance. Sleep, during the same period, was measured by wrist actigraphy.

Results: The median pulse rate showed decreased values pre call (median (iqr)) 64 (56-70)) compared with on call values (81 (70-91), $p < 0.001$). Increased HF activity was found in pre call values (199 ms^2 (75-365)) compared with on call values (99 ms^2 (48-177), $p < 0.001$). The LF/HF ratio was lower pre call (median of 2.7 (1.9-3.9)) compared with on call (4.9 (3.7-6.5), $p < 0.001$). Sleep between 22:00 to 06:00 hours was median(iqr) 390(358-419) minutes on the pre call night and 51(32-152) minutes on the on call night ($p < 0.001$, wilcoxon test). The surgeons were awake for median(iqr) 91(62-123) minutes on the pre call night and for 430(329-449) minutes on call ($p < 0.001$, wilcoxon test).

Conclusion: Surgeons working night shifts had a significant decrease in heart rate variability and a significant increase in pulse rate, representing sympathetic dominance in the autonomic nervous system.

Support (If Any): The study was financially supported by The Tryg Foundation and The Danish Medical Association.

0226

BLOOD PRESSURE AND BAROREFLEX FUNCTION IN HEALTHY HUMANS: EFFECTS OF REPETITIVE SLEEP RESTRICTION

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Introduction: The baroreflex helps to maintain blood pressure (BP) homeostasis. When BP rises, baroreceptors are activated leading to decrease in heart rate (HR); when BP decreases, baroreflex causes HR increases accordingly. Cardiovascular baroreflex sensitivity (BRS) can be estimated by linear relations between changes in systolic blood pressure (SBP) and R-R interval (RRI). Impairment of BRS contributes to sympathetic overactivity and increases in BP. Based on a known association between hypertension and short sleep; we predicted that repetitive challenge of sleep restriction would increase BP and impair resting BRS.

Methods: In a 22-day protocol, eight healthy subjects (age 38 ± 4 yrs; 4 men and 4 women) were randomly assigned to repeated sleep restriction (SR) group (4 h of sleep/night for 3 nights followed by a recovery sleep, repeated 4 times), or sleep control (SC) group. Beat-to-beat BP and HR were recorded during six 24-hour periods: baseline, experimental (third day of each cycle), and recovery. Spontaneous sequence method was used to estimate BRS from up-up (UU) sequences (progressive increases of SBP followed by lengthening of RRI) and down-down (DD) sequences (progressive decreases of SBP with subsequent shortening of RRI).

Results: Twenty-four hour SBP was significantly increased (to 14.6 ± 6.2 mmHg) in SR ($p = 0.036$) but showed no change in SC. HR responses were not different between SR and SC. Sleep restriction did not alter overall BRS during 24-hour periods from either UU or DD sequence. However, BRS tended to be impaired with UU sequence during sleep in SR (to -4.6 ± 2.3 ms/mmHg, $p = 0.059$) but was not changed in SC. Results from DD sequence showed no differences during sleep between two groups.

Conclusion: Repetitive sleep restriction with insufficient intervening recovery sleep, a common sleep-wake pattern in daily life, increased BP. These preliminary data suggest that the increased pressor response seen in sleep restriction is associated with impairment of BRS during sleep.

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0227

SLEEP HABITS REFLECT IN FUNCTIONAL BRAIN NETWORK ORGANIZATION

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Introduction: Cognitive performance and emotional wellbeing vary with sleep, with insufficient sleep exerting powerful, yet heterogeneous effects on brain function. We applied graph theory to resting-state functional MRI data to investigate patterns of functional brain network organization in relation to positive and negative habitual sleep balance (sleeping more and less than subjectively needed respectively).

Methods: We studied resting-state functional MRI data of 42 healthy adults (positive habitual sleep balance: $n = 23$; negative habitual sleep balance: $n = 19$). Neuroimaging data were processed in SPM8 using the CONN, ART and Graph Theory toolboxes. Age, gender, IQ and hours of sleep obtained the night prior to MRI served as nuisance variables in all analyses.

Results: Across all regions, negative sleep balance was associated with greater characteristic path length compared to positive sleep balance, suggesting a less effective information transfer. Compared to positive habitual sleep balance, negative habitual sleep balance was associated with greater nodal degree and betweenness of several regions, including right anterior and posterior cingulate, bilateral putamen, right pallidum, right angular gyrus, and right dorsomedial prefrontal cortex, suggesting greater functional interaction and integration of these regions. In contrast, compared to negative habitual sleep balance, positive habitual sleep balance was associated with greater cluster coefficients of several brain regions, including the right ventromedial prefrontal cortex and right angular gyrus, indicating greater local functional segregation. Greater network interaction and integration in association with positive habitual sleep balance was indicated by greater nodal betweenness of the ventromedial prefrontal cortex and left superior temporal pole among other regions. The right thalamus and bilateral amygdala emerged as functional hubs of network interaction and integration in the positive sleep balance group.

Conclusion: Sleep habits reflect in the organization of functional brain networks in such that brain regions involved in emotion regulation, gating of information and decision-making, including the amygdala, the thalamus and the ventromedial prefrontal cortex, are more integrated in the overall brain network if sufficient sleep is obtained on a habitual basis.

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0228

ASSESSING THE IMPACT OF CHRONIC SLEEP RESTRICTION AND ACUTE SLEEP DEPRIVATION ON PERFORMANCE-ASSOCIATED REGIONAL BRAIN ACTIVATION USING NEAR INFRARED SPECTROSCOPY

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Introduction: Shift workers are at elevated risk for sleepiness-related accidents as a consequence of acute and chronic sleep loss and circadian misalignment from their extended work hours and shifting work schedules. A potential approach to reduce this risk is use of objective, non-invasive monitoring technology. Near-Infrared Spectroscopy (NIRS) is a relatively new technology that quantifies hemodynamic changes in oxygenated and deoxygenated blood within the brain that reflect alterations in regional brain activity. Sleep deprivation reduces activation in the prefrontal cortex (PFC), a brain region important for cognitive performance and executive function. We tested whether ambulatory NIRS monitoring of PFC activation would be an effective monitoring tool for decreased objective performance and/or focused wakefulness.

Methods: PFC activity was measured with the NIRS during cognitive performance testing [10-min psychomotor vigilance task (PVT)] and quiet focused wakefulness [Karolinska Drowsiness Test (KDT)] in healthy volunteers participating in either (i) a 32-day forced desynchrony inpatient study assessing the effects of chronic sleep restriction (CSR; multiple consecutive days of insufficient sleep) or (ii) a 30-hr acute sleep deprivation inpatient study (ASD; single episode with extended wake).

Results: Preliminary assessment of the hemodynamic response to individual PVT trial presentations reveals an immediate decrease in oxygenated blood, followed by a larger increase, while deoxygenated blood shows an inverse response. Analyses of the effects of circadian timing and sleep loss on PFC hemodynamic response to PVT and KDT tasks are ongoing.

Conclusion: Monitoring PFC activity with NIRS may be an objective, non-invasive and cost-effective method for monitoring and detecting de-

creased alertness. The ambulatory NIRS approach may be applicable in shift-working populations at risk of sleepiness-related accidents including firefighters, pilots, health care providers, truck drivers and military personnel.

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0229

RELATION BETWEEN COGNITIVE FUNCTION AND CORTICAL OXYGENATION IN YOUNG ADULTS

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Introduction: Near infrared spectroscopy (NIRS) has enabled the non-invasive investigation of brain functions in psychiatric disorders with measurement of oxyhemoglobin (oxyHb) concentrations. We have demonstrated that short sleep duration and excessive daytime sleepiness impaired cortical oxygenation response during word fluency task. The purpose of this study was to investigate the relation between cognitive function and cortical oxygenation using NIRS in young adults.

Methods: This study included 25 university students (12 male and 13 female, age 22.0 ± 1.7 yrs). The relative concentrations of oxyHb were measured with frontal probes every 0.1 sec during word fluency task with NIRS machines at two wavelengths of near-infrared light (760 and 840 nm). The task consisted of a 60-sec pre-task baseline, a 60-sec word fluency task and a 60-sec post-task baseline. The area under oxyHb change was served as cortical oxygenation index. The cognitive function was evaluated using Wisconsin Card Sorting Test (WCST), continuous performance test identical pairs version (CPT-IP), and 2-back task. Sleep complaints and excessive daytime sleepiness were evaluated by Pittsburgh Sleep Quality Index (PSQI) and Epworth sleepiness scale (ESS), respectively.

Results: Accuracy of CPT-IP was significantly correlated with the area under oxyHb change. Other cognitive function task, accuracy and reaction time in 2-back task and category achievement, perseverative errors in Milner and difficulty of maintaining set in WCST did not show significant correlations with the area under oxyHb change. There were no significant relation between the area under oxyHb change, PSQI and ESS.

Conclusion: Decrease in cortical oxygenation response during word fluency task was related to impairment of sustained attention. The changes of cortical oxygenation might play an important role in cognitive dysfunction.

0230

SLEEP RESTRICTION IMPAIRS HIGHER-ORDER COGNITIVE PERFORMANCE IN HUMANS

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Introduction: Several nights of sleep restricted to 4-5 h sleep opportunities per night are reported to result in waking neurobehavioral performance deficits. Extending sleep however, prior to undergoing a period of sleep restriction, may have a protective effect on cognitive performance. We conducted a study utilizing a counterbalanced crossover research design to examine higher-order cognitive function during a simulated

work week of insufficient sleep as compared to an adequate sleep control condition.

Methods: Sixteen healthy adults (8 women) completed an inpatient protocol consisting of 3 baseline days [9 h time in bed (TIB)], followed by two sleep opportunity conditions (5 h or 9 h TIB, 5 days each, cross-over). The cognitive test battery was given every 2 h beginning 1.5 h after scheduled wake time and consisted of: the STROOP color word task, and a paired-addition (ADD) task. STROOP outcomes included: executive function [Exe, calculated as (inhibitory – facilitated median reaction time)], and facilitated median reaction time (FacMedRt). For the ADD task, the number of correct responses was examined. Outcomes were averaged across each condition day (CD).

Results: Condition differences were dependent on condition order. Exe and FacMedRt were worse by CD 3 when short sleep occurred first. Similarly, ADD performance was worse when short sleep occurred first and remained significantly lower throughout the protocol (all $p < 0.05$).

Conclusion: These findings indicate that higher-order cognitive function is impaired during insufficient sleep schedules. Obtaining adequate sleep before undergoing sleep restriction helped to maintain performance and thus may provide evidence for the benefit of banking sleep to maintain cognitive function during periods of sleep restriction.

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0231

CHRONIC SLEEP RESTRICTION LEADS TO DISSOCIATION OF SUBJECTIVE AND OBJECTIVE SLEEPINESS

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Introduction: Acute and chronic sleep deprivation experiments show that lack of sleep can have severe consequences for performance. In a sleep-deprived state people may not be aware of their worsening performance. We tested the hypothesis that under conditions of chronic sleep restriction (CSR) subjective sleepiness becomes dissociated from objective sleepiness as measured by performance.

Methods: 12 healthy adults (23 ± 2 yrs; 6f) participated in a 39-day study. After spending 10 h/night time in bed (TIB) at home for 3 wk, the inpatient study began with six 24 h baseline days (10-16 h TIB), followed by 3 wk of CSR-forced desynchrony during which subjects lived on 28 h days (6.5 h TIB/28 h, equivalent to 5.6 h TIB/24 h) for 18 days. Subjective sleepiness was assessed with a Karolinska Sleepiness Scale (KSS) and a visual analog scale (VAS) twice per hour. Performance was assessed with a Psychomotor Vigilance Task (PVT) every 4 h. One-Way RT ANOVA followed by Holm-Sidak post-hoc test was used for statistical analysis.

Results: PVT performance (mean RT) deteriorated across the CSR segment of the study ($p < 0.01$). In contrast, subjective sleepiness increased immediately on the first day of CSR ($p < 0.01$), but then stabilized and did not continue to increase across the CSR ($p > 0.05$), even though objective performance continued to worsen.

Conclusion: While both subjective and objective sleepiness (as measured by RT performance) initially increased when sleep restriction was first imposed, these quickly became dissociated over the course of the CSR such that subjective sleepiness stabilized to a level slightly higher than baseline and no longer reflected the continuous degradation in objective performance. These results have important implications for the assessment of sleepiness, and provide additional evidence that subjective measures are inaccurate in conditions of chronic insufficient sleep.

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0232

THE RELATIONSHIP BETWEEN SUBJECTIVE ALERTNESS AND OBJECTIVE PERFORMANCE DURING CHRONIC SLEEP RESTRICTION

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Introduction: Insufficient sleep decreases cognitive performance, creating safety concerns for many occupations. Since people often rely on their self-perceived level of alertness to decide if they should engage in a task, we investigated how well subjective ratings of alertness predict cognitive performance in participants with and without chronic sleep restriction (CSR) on a forced desynchrony (FD) protocol.

Methods: Seventeen healthy young participants lived on 42.85-hour days. Eight participants in the control group were awake 28.57 hours per day; nine participants in the CSR group were awake 32.85 hours per day. Multiple times each day, subjective alertness was measured with the visual analogue scale (VAS), and objective performance was measured using the psychomotor vigilance task (PVT). Linear, exponential, and logistic mixed-effects models were used to determine if variations in VAS ratings account for variations in PVT mean within each testing session. Subject-specific effects were included in the mixed-effects model to account for systematic differences between individuals. Circadian phase, hours since awakening, and hours of missed sleep since the start of the protocol were also included in the model.

Results: Variations in VAS ratings alone accounted for a small percentage of variations in PVT mean (adjusted-r-squared = 0.225). Inclusion of circadian phase, time since awakening, hours of missed sleep, and subject-specific effects improved the prediction (adjusted-r-squared = 0.728). In both study groups, there was a 3rd order polynomial relationship between PVT mean and PVT standard deviation with small subject-specific effects; as previously reported, PVT standard deviation increased with increasing PVT mean (polynomial fit; adjusted-r-squared = 0.947).

Conclusion: These results suggest that an individual's self-reported alertness alone cannot accurately predict vigilant performance; other information must be included. This result has implications for safety.

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0233

NEURAL CORRELATES OF THE PSYCHOMOTOR VIGILANCE TASK IN SLEEP-RESTRICTED ADOLESCENTS: AN FMRI STUDY

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Introduction: Adolescents commonly get 1-3 hours less sleep on school nights than is recommended. Sleep deprivation studies reveal that lack of sleep diminishes attention, and have begun to detail the neurological underpinnings for this effect in adults. However, little is known about how the adolescent brain responds to chronic sleep restriction (SR). This neuroimaging study compared brain response to a vigilance task under healthy sleep (HS) vs. SR.

Methods: Thirty-three typically-developing teens ages 14-16 underwent a 3-week within-subject protocol: a baseline week followed by 2 experimental weeks with 5 nights of 6.5 hours (SR) or 10 hours (HS) in bed, with random cross-over and 2-day wash-out. Teens underwent fMRI on the mornings at the end of HS and SR, performing a psychomotor vigilance task that measured reaction time (RT) in response to stimuli presented at random intervals. Imaging data were analyzed using an event-related general linear model, comparing events with the slowest 20% vs. the fastest 20% of RT. We also examined event onsets 4 seconds preceding the stimuli to capture anticipatory brain state.

Results: During SR, fast RT had greater activation than slow RT in striatum, motor cortex, and bilateral parietal areas, and slow > fast activation in the medial frontal region. The HS condition resulted only in striatal activation for fast > slow RT. Brain state prior to slow RT showed stronger activation than fast RT in posterior cingulate and fusiform/parietal regions during SR, and in the hippocampus during HS.

Conclusion: During SR, "default-mode" brain states, linked to daydreaming, preceded teens' slow RT, followed by a presumably reactive increase in activation of motor and attention regions. When well-rested, the same teens showed less variation in activation between slow and fast RT. Brain circuits underlying daydreaming may be particularly relevant to inattention among chronically sleep-deprived teens.

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0234

INCREASED PVT SENSITIVITY WITH REDUCED LAPSE CRITERION

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Introduction: A commonly used measure of performance on the Psychomotor Vigilance Test (PVT) is the number of lapses of attention during a test bout. This measure is highly sensitive to sleepiness, increasing as a function of prior wakefulness modulated by circadian rhythm. For the PVT, a lapse of attention is traditionally defined as a reaction time (RT) longer than 500 ms. By modifying this threshold, the sensitivity of the test may be changed. One way to quantify the sensitivity is through the effect size, Cohen's f^2 , where $0.15 < f^2 < 0.35$ indicates medium effect size and $f^2 > 0.35$ indicates large effect size. We estimated the optimal lapse threshold, defined as yielding maximal effect size, for a 10 min PVT administered on a laptop and for a 3 min PVT administered on an iPad during a total sleep deprivation experiment.

Methods: 16 healthy subjects (ages 22-40; 9 females) completed a 5-day (4-night) in-laboratory study. All subjects had an adaptation day and a baseline day (each 10 h TIB; 22:00-08:00) and subsequently underwent 38 h total sleep deprivation followed by a recovery night. During adaptation, subjects practiced the 10 min laptop PVT and the 3 min iPad PVT. Every 3 h during the baseline and sleep deprivation days, subjects took the 10 min laptop PVT, had a 20 min break, and then took the 3 min iPad PVT. For both PVT versions, the number of lapses in each test bout administered during the 38 h sleep deprivation period was calculated with lapse criteria ranging from 200 ms to 500 ms in steps of 5 ms.

Results: Using the traditional lapse criterion of 500 ms, the 10 min laptop PVT showed large effect size ($f^2 = 0.42$) and the 3 min iPad PVT showed small effect size ($f^2 = 0.13$). For the current data, the effect size on the laptop PVT was maximized ($f^2 = 0.64$) when the lapse threshold was set at 390 ms, and the effect size on the iPad was maximized ($f^2 = 0.38$) when the lapse threshold was set at 280 ms.

Conclusion: Based on effect size, the 3 min PVT administered on an iPad was less sensitive to the effects of 38 h total sleep deprivation than the 10 min PVT administered on a laptop. However, by decreasing the

lapse threshold to 280 ms, the sensitivity of the 3 min PVT approached that of the 10 min PVT with the traditional lapse criterion of 500 ms.

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0235

EQUIVALENCE TESTING FOR IN-FLIGHT SLEEP AND PVT PERFORMANCE OF AIRLINE PILOTS

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Introduction: To manage fatigue risk among commercial airline pilots, fatigue risk management systems (FRMS) are being introduced that are required to deliver an equivalent level of safety to prescriptive flight and duty time limits. Lack of statistical difference does not imply equivalence. Equivalence testing was used to compare in-flight sleep in a full rectangular bunk versus one that tapered slightly from about hip-height to the foot.

Methods: Independent ethical approval was obtained. Thirty-five pilots were monitored on an out-and-back trip crossing 5-6 time zones (median outbound flight = 11.7 hrs, inbound = 11.9 hrs, median layover = 26.5 hrs, 4-person crews). Twenty pilots used the full bunk outbound and the tapered bunk inbound; 15 did the reverse. Sleep was measured using actigraphy and duty/sleep diaries, and a 5-min psychomotor vigilance task (PVT) performance test was undertaken at top of descent (TOD). Practical equivalence for total in-flight sleep was defined as ≤ 30 min, based on: 1) significant decrements in PVT performance occurring only after ≥ 2 nights of laboratory sleep restriction to 3-5 hrs; 2) a polysomnographic study of pilot sleep that found a 53-min difference in total in-flight sleep between command and relief crew but no difference in PVT performance at top of descent (TOD). For mean PVT response speed at TOD, practical equivalence was defined as having a mean difference within the 95% CI of the mean test-retest difference for 70 B777 flight crewmembers measured twice under the same pre-flight conditions (± 0.307 responses/sec).

Results: Comparing the two bunks, total in-flight sleep was equivalent (mean difference 95% CI = -24.48 min to +22.41 min) and mean PVT response speed at TOD was equivalent (mean difference 95% CI = -0.19 responses/sec to +0.24 responses/sec).

Conclusion: Equivalence testing is a valuable additional tool for demonstrating that different fatigue mitigation strategies are likely to deliver an equivalent level of safety.

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0236

SHIFT WORK, EDUCATION, AND SHORT SLEEP DURATION

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Introduction: Shift work is conducted outside of standard daytime hours or on a rotating basis and has been associated with adverse sequelae. Similarly, persons with less than a high school education have been found to be at increased risk for short sleep duration. To better address the relationships between shift work, education, and short sleep duration, we examined the association of work shift with sleep duration and education in a large sample of community-dwelling adults.

Methods: 12,288 participants aged 20-64 years completed all relevant questions on the 2005-2010 National Health and Nutrition Examination Survey, a multi-stage, stratified probability survey assessing non-institutionalized civilians. Short sleep duration was defined as reporting usually sleeping < 6 hours on workdays or weekdays. Respondents were categorized as $<$ high school graduate, high school graduate, some col-

lege, or college graduate. Work shift was characterized as 1) regular daytime shift, 2) evening or night shift, 3) rotating shift, or 4) not working. Prevalence ratios (PRs) and 95% confidence intervals (CIs) were adjusted for age, socioeconomic variables, and risk behaviors.

Results: The weighted percentages of short sleepers were 36.2%, 49.4%, 39.6%, and 38.2% for the four shift groups, respectively. The final logistic regression model revealed evening or night shift work was associated with a significantly greater likelihood of short sleep duration relative to daytime shift work (PR = 1.24, 95% CI = 1.14-1.36). College graduates reported a significantly lower prevalence of short sleep duration ($p < 0.0001$) relative to others, although there was no interaction between education and shift work on sleep duration.

Conclusion: Evening or night shift work was associated with short sleep duration. However, no significant differences were evident in the prevalence of short sleep duration between respondents reporting daytime shift work, no work, and—in contrast to previous investigation—rotating shift work.

0237

NEUROBEHAVIOURAL EFFECTS OF “CATCH-UP” SLEEP IN MEN WITH LIFESTYLE DRIVEN, CHRONIC, INTERMITTENT SLEEP RESTRICTION

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Introduction: Chronic, intermittent sleep restriction is common in modern society and the neurobehavioural effects of chronic sleep loss are increasingly recognised.

Methods: 19 men (mean \pm SEM age 28.6 ± 2.0 years, BMI 26.0 ± 0.8 kg/m²) with at least 6 months' history (5.1 ± 0.9 years) of lifestyle driven, restricted sleep during the working week ($6h13min \pm 7$ min/night) with regular weekend 'catch-up' sleep (weekend sleep extension $37.4 \pm 2.3\%$) completed an in-laboratory, randomised, cross-over study comprising 2 of 3 conditions, stratified by age. Conditions were 3 weekend nights of 10 hours 'catch-up' sleep, 6 hours sustained sleep restriction or 10 hours 'catch-up' sleep with slow wave sleep suppression using acoustic stimuli. Reported sleep was verified at screening and before each laboratory visit by two weeks of actigraphy. A neurocognitive test battery comprising N-back, Stroop, Tower of London and Psychomotor Vigilance Task (PVT) was performed on days 2 and 3, two hours after wake time. Subjective sleepiness was assessed with the Karolinska Sleepiness Scale at frequent timepoints over both days. Driving simulation was performed at 2100 hrs both evenings.

Results: Subjective sleepiness was worse following sustained sleep restriction compared to 'catch up' sleep and SWS suppression (both $p < 0.0001$). Measures of vigilance on the PVT (all $p \leq 0.005$), 1-back accuracy ($p = 0.01$) and driving simulator braking response time ($p = 0.009$) improved following 'catch-up' sleep compared to sustained sleep restriction. Similar changes were also seen in 2-back ($p = 0.03$), 3-back ($p = 0.002$) and Stroop colour ($p = 0.01$) response times in the younger men exclusively. SWS suppression did not alter parameters consistently compared to 'catch-up' sleep or sustained sleep restriction, however certain PVT responses (mean RT, slowest 10% RT) were slower in this cohort compared to 'catch-up' sleep ($p \leq 0.03$), despite no difference in subjective sleepiness.

Conclusion: 'Catch-up' sleep provided improvements in subjective sleepiness and measures of objective vigilance and reaction time tasks

across several neurocognitive domains compared to sustained sleep restriction in this cohort of men with chronic, intermittent sleep restriction. **Support (If Any):** Study was supported by the Australian NHMRC Centre for Integrated Research and Understanding of Sleep (CIRUS).

0238

REPEATED CHRONIC VARIABLE SLEEP DEFICIENCY ATTENUATES NEUROCOGNITIVE RECOVERY FOLLOWING AN EXTENDED SLEEP OPPORTUNITY

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Introduction: Progressive performance deterioration during multiple consecutive nights of stable but reduced sleep is well documented. In real-world settings, however, night-to-night sleep durations vary considerably. Here we investigate the effects of three cycles of two 3-hour time-in-bed (TIB) opportunities interspersed with one 10-hour TIB opportunity on neurocognitive performance and sleepiness.

Methods: Eight young healthy male participants (mean age \pm SD: 23.9 \pm 2.4 years) completed the 11-day protocol, consisting of a baseline 10-hour sleep opportunity, followed by three cycles of two 3-hour time-in-bed opportunities and one 10-hour time-in-bed opportunity. Participants received one of three polychromatic white light interventions (200 lux 4100K [background] then 200 or 400 lux 17000K in random order) for 3.5 hours on the morning following the second 3-hour time-in-bed opportunity of each cycle. Participants completed regular assessments of neurobehavioral performance, mood, and subjective sleepiness.

Results: Psychomotor vigilance task performance and subjective sleepiness deteriorated cumulatively following the two 3-hour time-in-bed opportunities during the first cycle, and showed marked improvement after the first 10-hour time-in-bed recovery sleep. When re-challenged with chronic sleep loss, however, psychomotor performance returned to the previous level of impairment and continued to decline despite additional recovery sleep opportunities. Conversely, subjective sleepiness maintained a similar pattern throughout each cycle. Sleepiness and performance were not improved significantly by blue-enriched light exposure. **Conclusion:** Our results show that chronic variable sleep deficiency induces a cumulative deterioration of performance, inconsistent with current models of sleep-wake regulation. A single-night recovery sleep is insufficient to restore performance when re-challenged under chronic variable sleep deficiency, despite apparent transient recovery. Subjective measures of sleepiness do not reflect the increase in objective performance impairment under such conditions.

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0239

SLEEP INERTIA DURING CHRONIC SLEEP RESTRICTION IS AFFECTED BY CIRCADIAN PHASE, LENGTH OF TIME AWAKE, AND DURATION OF SLEEP RESTRICTION

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Introduction: Sleep inertia, the transient neurobehavioral deficit upon awakening, is assumed to reflect the persistence of sleep maintenance

mechanisms on the waking brain. We investigated kinetics of sleep inertia as a function of circadian phase, length of time awake, and chronic sleep restriction.

Methods: 17 individuals (4 F, 19-34 years) from two different forced desynchrony (FD) protocols were studied: 1) With Chronic Sleep Restriction (CSR) (Cohen et al 2010) and 2) without CSR (Wyatt et al 2004). During FD, for the CSR group each "day" included 32.85 hr of wake and 10 hr of sleep; for the control group each "day" included 28.57 hr of wake and 14.28 hr of sleep. Visual analog scales (VAS) were presented every 10-30 minutes beginning 1 minute after scheduled awakening; the Digit Symbol Substitution Task (DSST) was presented every 10 minutes beginning 1 minute after awakening in the CSR group. Circadian phase was determined from hourly serum melatonin samples. Mixed model longitudinal analyses were performed with subject as the random factor and group, time awake, beat cycle (e.g., week within the protocol) and circadian phase as the fixed factors.

Results: VAS alert significantly varied by circadian phase and time awake, but the timecourse of dissipation was not influenced by phase or chronic sleep restriction. The interaction of phase*group*beat cycle was significant, predominantly explained by substantially worse performance during chronic sleep restriction when waking at the circadian performance nadir. Similarly, for DSST in the CSR group, there was significant phase*beat cycle interaction with disproportionately worse performance in the 2nd and 3rd week of the protocol at the circadian nadir.

Conclusion: The degree of neurobehavioral impairment upon awakening at the circadian performance nadir, but not its timecourse of dissipation, is significantly worse under conditions of chronic sleep restriction. For individuals who might need to work immediately after being awoken (e.g., medical professionals) or who plan to work after a nap, these physiological facts should be considered.

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0240

SENSITIVITY TO SLEEP LOSS IN TODDLERS: SLOW WAVE ENERGY (SWE), WORKING MEMORY, AND SELF-REGULATION

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Introduction: Early childhood is a time of rapid developmental changes in sleep, executive function, and self-regulation, a construct reflecting the ability to control one's behavior, attention, and emotion when challenged. Most toddlers meet part of their sleep need via napping. Our prior work has shown striking individual differences in the homeostatic response (slow wave energy; SWE) to missing a daytime nap. This study further expands understanding of toddler's sensitivity to sleep loss by examining associations between nap-dependent changes in SWE and in executive function and self-regulation.

Methods: Healthy children (n = 18; 9 males; ages 30-36 months) followed a strict sleep schedule for ≥ 3 days before each of 2 randomly assigned, counterbalanced sleep recordings: Baseline (midday nap and night sleep at scheduled bedtime) and sleep restriction (missed nap and night sleep starting after 13 h of prior wakefulness). Total 24 h SWE was computed as cumulative slow wave activity (1.25-4.5 Hz; C3A2) in both

conditions. Children also completed an assessment of working memory, a dimension of executive function, on a baseline and sleep restriction day. Working memory was measured as % responses correct. Self-regulation was coded from videos of the assessment and operationalized as % time off-task and % time non-compliant (e.g., task refusal, getting out of chair). Differences in all variables were computed between baseline and sleep restriction conditions. Partial correlations controlling for age and order were computed.

Results: On the baseline day, average nap duration was 87.6 ± 35.2 min and subsequent nighttime sleep duration was 609.1 ± 36.0 min. Average sleep duration on the night after missing a day nap (sleep restriction) was 628.2 ± 30.2 . Poorer compensation of sleep loss (i.e., less SWE in sleep restriction than baseline) was associated with worse working memory (% responses correct, $r = 0.77$, $p = 0.002$) and self-regulation (% time off-task, $r = -0.86$, $p < 0.001$; % time non-compliant, $r = -0.82$, $p = 0.001$) after a missed nap relative to baseline.

Conclusion: Toddlers who compensated less for sleep loss had larger decrements in working memory and self-regulation. These novel findings suggest large individual differences in toddlers' tolerance to missing a nap, which may reflect their sensitivity to sleep loss during wakefulness. Over time, poor compensation of missed sleep may increase children's risk for deficits in basic developmental skills, such as executive function and self-regulation.

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0241

LOCAL SLEEP IN WAKEFULNESS AND BEHAVIORAL PERFORMANCE

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Introduction: Previous work in humans demonstrated that behavioral manipulations targeting particular cortical areas during prolonged wakefulness lead to a local, region-specific homeostatic increase in theta EEG power density (5-9 Hz). It has been suggested that theta waves could represent temporary neuronal OFF periods. In awake rats, the occurrence of an OFF period in a brain area relevant for behavior resulted in specific performance errors. The present study aimed at further investigating the local homeostatic regulation of theta waves in humans and their precise relationship with negative behavioral outcomes.

Methods: Fourteen subjects (12 right-handed, 23.7 ± 3.5 y, 8 females) participated in two prolonged wakefulness experiments (24-h). During each experiment, volunteers were exposed to six 2-h sessions of either a driving simulation game (DS) or a 'frontal battery' (FB), including visual tasks based on impulse control and conflict resolution (e.g., Stroop task). High-density EEG (256 channels) recordings were obtained at baseline and after each task session, both during an eyes-open resting condition and during a go/nogo test aimed at assessing the individual impulse control performance. An automated theta-wave detection algorithm was applied to all recordings.

Results: Both tasks were associated with a global increase of a composite value taking into account both the density and amplitude (TDA) of theta waves. Analyses contrasting topographical changes between the two tasks also revealed a specific local increase that was more evident after the first 10 hours of waking, concomitantly with a temporary reduction in global TDA values, and which tended to disappear afterwards. Specifically, DS led to a local TDA increase over the parieto-occipital derivations, while FB resulted in an increase over frontal derivations (p

< 0.05). Preliminary analyses (8 subjects, FB condition) also revealed that commission errors during the go/nogo test were more likely to be associated with a frontal theta wave in the 400 ms around stimulus presentation. By contrast, omission errors (missing response or reaction time > 500 ms) were associated with theta waves in parieto-occipital derivations ($p < 0.05$).

Conclusion: Our results confirm previous observations of a local, use-dependent regulation of sleep propensity. In addition, preliminary results suggest a specific association between local sleep episodes during wakefulness in humans and performance errors.

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0242

REGION SPECIFIC DIFFERENCES IN THE FUNCTIONAL CONNECTIVITY OF THE DEFAULT MODE NETWORK DURING NORMAL AND RECOVERY SLEEP

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Introduction: Sleep deprivation is associated with widespread changes in cognition and brain activity in multiple sub-cortical and cortical brain regions. Subsequent recovery sleep is recognised as physiologically different to normal sleep, but the differences in brain activity and functional connectivity (FC) have not been characterised. Default mode network (DMN) activity is sensitive to sleep stage, sleep deprivation and the posterior cingulate cortex (PCC) is of particular interest due to its link with the maintenance of consciousness. We investigated whether FC of the DMN during recovery sleep is different from FC during normal sleep.

Methods: Eight healthy subjects (4 males, age 29 ± 5 years) underwent separate simultaneous EEG-fMRI (64 channel EEG at 3T) sessions: 1) at their usual bedtime; 2) following 24-hours of sleep deprivation. Two subjects were subsequently excluded for technical reasons, and all EEG data was sleep-staged according to standard AASM guidelines. Seed-based FC analysis was used to calculate all pair-wise connectivity between 8 regions of the DMN. FC was averaged according to sleep stage, separately for the normal and recovery sleep sessions. A generalized linear mixed-model was then used to determine the differences associated with each sleep stage and also between normal and recovery sleep for all DMN regions.

Results: DMN region was a significant predictor of FC ($p < 0.001$), as was sleep stage ($p < 0.001$). Sleep type alone was not significant ($p = 0.433$), although there was a significant interaction between sleep type and region ($p < 0.001$) suggesting the type of sleep affects certain DMN regions. There was a stage by region interaction ($p = 0.045$) indicating FC was affected by sleep stage and dependent upon DMN region.

Conclusion: The strength of FC in the DMN differed between normal and recovery sleep for certain DMN regions, this suggests FC during sleep is modulated by prior sleep deprivation in a regionally specific manner.

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0243

HAEMODYNAMIC CORRELATES OF K-COMPLEXES AND VERTEX SHARP WAVES OF NREM SLEEP UNDER DEPRIVED AND NON-SLEEP DEPRIVED CONDITIONS*Rollings DT^{1,2}, Wilson R¹, Mayhew SD¹, Bagshaw AP¹*¹Birmingham University Imaging Centre, University of Birmingham, Birmingham, United Kingdom, ²Department of Neurophysiology, Queen Elizabeth Hospital Birmingham, Birmingham, United Kingdom

Introduction: The K-complex (KC) and vertex sharp wave (VSW) are two major graphoelements that are unique to sleep. The investigation into their functional role has resulted in a dichotomy between a sleep protective role and that of an arousal mechanism. In this study, we used combined electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) to help elucidate their functional role under non-deprived (ND) and sleep deprived (SD) conditions where homeostatic sleep drive is increased.

Methods: EEG-fMRI data were acquired from eight healthy subjects (5 males, mean age 29 years) on two separate occasions; ND session in the evening and another following 24 hours of sleep deprivation separated by 2 weeks. Subjects were free from any sleep or neurological disorders. One subject was excluded for failing to sleep in both sessions. Timings for KCs and VSWs were convolved with a canonical haemodynamic response function and its first temporal derivative using a general linear model in an event related design. A second level group analysis was performed.

Results: Group data for both KCs and VSWs demonstrated significant BOLD signal increases in multiple cortical (posterior & anterior cingulate, frontal, temporal cortices and regions contiguous to the vertex) and subcortical (thalamus and brainstem) regions for both ND and SD conditions. More widespread activation was observed in the SD group for both events. Of the multiple regions activated, both increases and decreases in activation were noted in more restricted regions for both KCs and VSWs as a result of sleep deprivation.

Conclusion: Our findings are concordant with previous EEG-fMRI studies and are supportive of a sleep maintenance role for both VSWs and KCs. Our results also demonstrate specific brain regions that show an increase or decrease in activation, for KCs and VSWs, as a function of increased homeostatic sleep drive.

0244

SLEEP DEPRIVATION IMPAIRS CORTICAL ACTIVATION, ATTENTION AND MEMORY: THE ROLE OF BASAL FOREBRAIN PARVALBUMIN NEURONS*Cordeira JW, Chen L, McNally J, Thankachan S, Basheer R, Brown RE, McKenna JT, Strecker RE, McCarley RW*
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Introduction: Gamma band oscillations (GBO, 30-80 Hz) are thought to synchronize behaviorally relevant interactions between brain regions. Sleep deprivation (SD) impairs cortical GBO and performance in attention and memory tasks in human and animal studies. Our laboratory has shown that parvalbumin (PV) positive GABA neurons in the basal forebrain (BF) are important for the generation of GBO in the cortex. Whether or not GBO generated by BF PV-GABA neurons directly mediate these cognitive processes, however, is not clear. Here, we tested whether cortical GBO generated by PV-GABA neurons is sensitive to SD and linked to attention and memory performance in the novel object recognition (NOR) task.

Methods: AAV vectors expressing double-floxed ArchT-GFP were injected into the BF of PV-Cre transgenic mice. Mice were implanted with optical fibers targeting the BF. Local field potential electrodes were placed in the prelimbic cortex (PrL), an area implicated in attention and

required for recognition memory. Cortical activity and performance in the NOR task were measured with SD or with bilateral laser illumination (532 nm) of ArchT.

Results: Novel object investigation evoked a transient increase in GBO power in the PrL. SD prior to object exposure impaired GBO evoked by novel object investigations and decreased time spent investigating, a measure of attention. Recognition memory as measured by next day preference for novelty was impaired by SD before, or after, initial object exposure. Bilateral inhibition of BF PV-GABA neurons via laser illumination of ArchT during novel object exposure impaired GBO and NOR performance, thus mimicking the effects of SD on these measures.

Conclusion: These data identify a key role for cortical GBO generated by BF PV-GABA neurons in attention and memory processes, suggesting a target to ameliorate SD-induced cognitive deficits.

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0245

THE LATE POSITIVE POTENTIAL (LPP) SHOWS GREATER ENCODING OF EMOTIONAL PICTURES AND A NEGATIVITY BIAS FOLLOWING SLEEP DEPRIVATION*Cote KA, Hunt B, Jancsar C*

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Introduction: Sleep deprivation has been reported to lead to central and peripheral nervous system reactivity to emotional pictures relative to neutral pictures. Event-related potentials (ERPs) index precise timing of cognitive processing of discrete stimuli. Picture stimuli elicit a late parietal-occipital slow-wave (300-1200 ms), the Late Positive Potential (LPP) which reflects encoding of valence and emotion regulation. We expected a larger LPP in the Sleep Deprived (SD) compared to Control (C) group, especially for negative stimuli.

Methods: IAPS pictures were presented (60 positive, 60 negative, 45 neutral; 1000 ms; ISI = 2-4 s) to young adults randomly assigned to 32-hr SD (n = 22) or C (n = 23) groups. Valence was rated for each picture using a 4-pt scale: very-positive, slightly-positive, slightly-negative, very-negative.

Results: There were significant Group-by-Valence interactions for LPP amplitude at three sites: CPz [$F(2,86) = 4.91, p = .010$], Pz [$F(2,86) = 4.32, p = .016$], and POz [$F(2,86) = 3.35, p = .048$]. Independent t-tests indicated SDs had a larger LPP than Cs to positive and negative pictures, but not neutral at all sites (p 's < .05). Paired t-test showed both groups had larger LPPs to positive and negative pictures relative to neutral as expected; only SDs had a larger LPP to negative vs positive stimuli (CPz: $t(21) = 2.41, p = .036$). The magnitude of difference in LPP amplitude for positive and negative pictures relative to neutral appeared much greater for SDs than Cs. LPP difference scores for negative-minus-neutral pictures were significantly greater for SDs than Cs at all sites (p 's = .028-.004), with only trends for a greater response in SDs to the positive-minus-neutral difference (p 's = .07-.10).

Conclusion: In an emotion categorization task, SDs showed a greater LPP response than Cs for positive and negative but not neutral pictures. SDs had a larger LPP to negative compared to positive pictures, and a greater magnitude of LPP amplitude difference for negative-minus-neutral stimuli compared to Cs. These data illustrate greater encoding of emotional picture stimuli and a negativity bias as a result of sleep loss.

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0246

THE IMPACT OF SLEEP DEPRIVATION ON THE VISUAL STRATEGIES UNDERLYING FACIAL EXPRESSION RECOGNITION

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Introduction: Recently, it has been shown that sleep deprivation (SD) impairs the ability to judge the intensity of emotions in facial expressions as well as the identification of those emotions. The visual strategies underlying these impairments have never been studied. Here, we used a psychophysical technique, i.e. Bubbles, to examine the visual information used by participants pre vs. post SD.

Methods: Fifteen total SD subjects (7 men, 8 women; 18 to 23 years old) underwent a facial expression categorization task with bubbled stimuli, pre and post SD. The Bubbles technique involves the presentation of sparse versions of emotional faces, created by sampling facial information at random spatial locations and at five non-overlapping spatial frequency bands. The average accuracy was maintained at 62.5% by adjusting the number of bubbles on a trial-to-trial basis. Classification images showing which information in the expressions correlated with participants' accuracy were constructed separately for trials occurring pre vs. post SD, by performing a multiple linear regression on the bubbles locations and accuracy. A cluster test was applied on the difference between the post and pre classification images for each spatial frequency band to determine statistical significance.

Results: We found that the participants showed a bias towards using more the naso-labial fold area in high spatial frequencies post SD than pre SD ($Z_{crit} = 4.12$, $p < 0.05$), and towards using more the right eye and mouth areas in low spatial frequencies post SD than pre SD ($Z_{crit} = 3.37$, $p < 0.05$).

Conclusion: Our results indicate that SD alters the visual information extraction strategies for recognizing facial expressions. We propose that the participant's bias at using more the lower part of the face in high spatial frequencies as well as the higher utilization of low spatial frequencies following SD might in part explain why SD affects more the processing of some facial expressions than others.

0247

THE IMPACT OF SLEEP DEPRIVATION ON THE ABILITY TO RECOGNIZE BLENDED HUMAN EMOTIONS

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Introduction: Recently, there has been an increased interest in the role of sleep in emotions. Some studies have shown that sleep deprivation (SD) impairs not only the ability to judge the intensity of emotions in facial expressions but also the identification of those emotions. However, current data are very sparse, non-systematic and even contradictory. The aim of the present study is to investigate the effect of total SD on emotion recognition using a sophisticated test, the Facial Expression Megamix.

Methods: Fifteen total SD subjects (7 men, 8 women; 18 to 23 years old) and 24 controls (CT) subjects (6 men, 18 women; 18 to 31 years old) underwent an adaptation of the Facial Expression Megamix. This test combines any two basic emotions (Disgust, Anger, Sadness, Surprise, Fear or Happiness) to create morphs with varying degrees (i.e. 14%, 26%, 38%, 50%, 62%, 74% or 86%) of each emotion. One ANO-

VA on the factors Groups (SD, CT) \times Emotions was calculated on the accuracy for the less ambiguous facial expressions (i.e. 74% and 86%).

Results: Results show a significant interaction Groups \times Emotions ($F(5,185) = 9.1$, $p < 0.001$). Post hoc comparisons reveal that recognition of mixed emotion was significantly impaired for Fear in the SD group (SD = 45% \pm 20; CT = 67% \pm 12; $p = 0.001$) and on the contrary, Happiness tends to be more easily recognized after SD (SD = 95% \pm 6, CT = 86% \pm 16; $p = 0.02$).

Conclusion: Our results confirmed that sleep is indeed an important factor to consider when studying the physiological processes involved in the recognition of human facial emotions. However, our results are not completely in accordance with those previously obtained by other research teams. Further studies are required in order to better understand how sleep is modulating these processes and the extent of its role in facial expression recognition.

0248

THE EFFECT OF SLEEP DEPRIVATION ON EVALUATIONS OF SEXUAL ATTRACTIVENESS

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Introduction: Human mating involves complex decisions. Because sleep deprivation has been shown to disrupt decision making in other contexts (e.g., moral, emotional, food choice), mating decisions could also be disrupted. Increased activity in reward related brain areas and decreased inhibitory frontal lobe activity following sleep deprivation led us to hypothesize increased perceptions of sexual attractiveness and increased interest in casual sex following sleep deprivation.

Methods: Before and after 24 hours of sleep deprivation, 29 female and 31 male heterosexual college students (age: $M = 19.5$, $SD = 1.3$) were presented images depicting opposite-sex faces of varying attractiveness (normal models, models created merging 3 and 6 faces; research has shown merged faces are perceived as more attractive). For each image, participants rated (from 1 to 7) the sexual attractiveness and likelihood of casual sex with the model.

Results: For sexual attractiveness, a 2 (time: pre and post sleep deprivation) \times 2 (participant sex) \times 3 (model: no-merge, 3-merge, and 6-merge) mixed-design ANOVA showed a significant 3-way interaction ($F(2,116) = 40.44$, $p < .05$). At baseline, participants rated the merged models as more sexually attractive than the no-merge models. Following sleep deprivation, men's ratings of the 6-merge models did not change. However, their ratings of the no merge models increased significantly (pre: $M = 2.72$, $SE = .14$; post: $M = 3.40$, $SE = .15$) and the 3-merge models decreased significantly (pre: $M = 4.07$, $SE = .13$; post: $M = 3.22$, $SE = .14$), such that these ratings converged at similar levels. Sleep deprivation did not affect women's ratings. Similar results were found for likelihood of casual sex.

Conclusion: Although sleep deprivation did not affect women's sexual evaluations, it led to an increase in men's ratings of the least attractive models and a decrease in discrimination between these models and models previously rated as more attractive. Our findings suggest sleep deprivation alters brain areas involved in human mating decisions.

0249

THE EFFECTS OF 18 HOURS OF SUSTAINED WAKEFULNESS ON CHANGES IN PARANOID AND DELUSIONAL BELIEFS IN GOOD SLEEPERS

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Introduction: Previous research in clinical populations indicates that many individuals diagnosed with psychotic disorders have difficulties initiating and maintaining sleep. Past studies focused mainly on clinically diagnosed insomnia and paranoia. Limited research directly examines normal variation in paranoia-type symptoms, including delusions, in good sleepers following sleep deprivation. Furthermore, no studies have examined the effects of sustained wakefulness over shorter time periods (such as 18 hours) on changes in global paranoia and specific delusion.

Methods: 30 good sleepers completed questionnaire measurements including the Karolinska Sleepiness Scale, Paranoid Ideation Scale, and the Delusions Inventory to measure 11 delusional components. The measurements took place at two time-points (time 1: during the day, a week prior sustained wakefulness; time 2: a week later following 18 hours of sustained wakefulness). Actigraphy was used to ensure compliance during the sustained wakefulness protocol.

Results: The level of sleepiness significantly increased from time 1 ($M = 2.83$, $SD = .83$) to time 2 ($M = 7.10$, $SD = 1.71$, [$t(29) = -12.117$, $p < .0001$]). Global paranoia significantly increased from time 1 ($M = 36.27$, $SD = 11.22$) to time 2 ($M = 39.53$, $SD = 13.82$, [$t(29) = -2.636$, $p = .013$]). There was a significant interaction between time and sleepiness on depersonalization, indicating that the increase in depersonalization was accentuated in individuals who were sleepier at time 2 [$t(29) = -2.591$, $p = .015$].

Conclusion: The current study is the first to demonstrate that 18 hours of sustained wakefulness significantly increases feelings of global paranoia and depersonalization in healthy good sleepers. This result is important as it suggests that a period of wakefulness not uncommon in the general population significantly influences psychotic-type symptoms. This has implications for our understanding of the role of sleep deprivation in the possible development of psychosis.

0250

THE EFFECTS OF CHRONIC, PARTIAL SLEEP DEPRIVATION ON RISK-TAKING BEHAVIOR IN RATS

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Introduction: The effects of sleep deprivation on risk-taking behavior have been minimally investigated, observing mostly the effects of total sleep deprivation in human models. Additionally, the research has shown mixed results. Little is known about chronic partial sleep deprivation on decision making. In a chronically sleep deprived society where many people (e.g. military, medical doctors) require rapid decision making to ensure the safety and welfare of others, it is of interest to investigate the effects of chronic partial sleep deprivation on risk-taking behavior. Utilizing a rodent model, the current study examined the effects of 5 days of partial sleep deprivation on risk-taking behavior in Wistar Han rats as measured by the Rodent Gambling Task.

Methods: Nine rats were placed in a slowly rotating wheel for 18 hours a day for 5 consecutive days followed by 2 days of recovery sleep. The rats' risk-taking behavior was measured each day using the Rodent Gambling Task. This task allows rats to nose-poke among 4 holes to

obtain an immediate reinforcer along with a probabilistic delay. Larger, immediate reinforcers are associated with longer probable delays whereas smaller immediate reinforcers are associated with shorter probable delays. Thus, across time, selecting the larger, immediate reward is considered to be a risky decision, as the rats lose the opportunity to gain reinforcers. We measured behavior across the entire experimental period and during two "recovery" days where they could obtain ad lib sleep.

Results: The results of a one-way repeated measures ANOVA revealed changes in risk-taking behavior in animals that were chronically partially sleep deprived.

Conclusion: Preliminary data suggests that chronic partial sleep deprivation increases risk-taking behavior as measured by the Rodent Gambling Task. Future studies will introduce d-amphetamine to potentially reverse effects.

0251

IMPAIRED RESPONSE SELECTION AND GAMMA ACTIVITY SYNCHRONIZATION AFTER SELECTIVE REM SLEEP DEPRIVATION AND SLEEP INTERRUPTIONS IN MAN

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Introduction: Total sleep deprivation results in impairment in prefrontal cortex-dependent functions, such as flexible thinking, and behavioral response selection. The dorsolateral prefrontal cortex, in charge of executive functions, is deactivated and uncoupled from posterior association areas during REM sleep. However, total sleep deprivation suppresses both REM and non-REM sleep. We investigated REM sleep deprivation compared to NREM sleep interruption effects on performance, and EEG activity during a task requiring response selection according to arbitrary abstract rules.

Methods: After 2 nights of adaptation in the laboratory, subjects ($n = 18$) were randomly assigned to two groups: selective REM sleep deprivation by awakening them at each REM sleep onset or the same number of NREM sleep awakenings as control for sleep interruption effects during the third night in the laboratory. The response selection rule-guided task was performed before and after sleep manipulation and EEG activity was recorded during task performance at the same time of day. REM sleep percentage was selectively reduced from 21% in baseline to 4% in the REM sleep deprived group only.

Results: Not only REM sleep deprivation, but also NREM sleep interruptions impaired the ability to select the adequate response in the rule-guided task for easy, as well as for difficult stimuli; whereas, loss of accuracy in rule implementation was associated with decreased gamma synchronization in right frontal derivations, and between left frontal and posterior association regions. Additionally, impairment in response selection in the REM sleep deprived group was associated with decreased gamma synchronization in left frontal regions.

Conclusion: The results of the present study suggest that uninterrupted sleep is needed for successfully select the adequate response in a rule-guided context and for the adequate prefrontal synchronization required for rule implementation.

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0252

SLEEP AND CIRCADIAN EFFECTS OF SIMULATED POSTPARTUM AWAKENINGS AMONG HEALTHY, CHILDLESS WOMEN

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Introduction: A complex process of physiological and environmental changes during the postpartum period confounds our understanding of the discrete impacts of postpartum sleep fragmentation. To isolate these effects, we manipulated the sleep of childless women in the laboratory to model a postpartum sleep fragmentation schedule. Actigraphically and polysomnographically-recorded sleep, daytime functioning, mood, and circadian outcomes were quantified.

Methods: Eleven healthy, childless women (25.4 [SD \pm 2.3] years, 72.7% white, \$23,000 [SD \pm \$11,000] household income) contributed continuous wrist actigraphy and daily psychomotor vigilance test (PVT) for one baseline week followed by 3 consecutive nights of overnight polysomnography: an adjustment/sleep disorder screening night, a baseline night, and a night of experimental sleep fragmentation during which they were awakened 3 times for 30-35 mins each. During nocturnal awakenings, women engaged in a standardized protocol that included feeding, changing, and rocking a doll in dim light (< 3 lux) to model postpartum motor activity and postures. First-morning baseline and fragmentation night voids were collected for 6-sulphatoxymelatonin assays. Baseline and post-fragmentation multiple sleep latency tests (MSLT) and profile of mood states surveys (POMS) were administered. A final week of at-home actigraphy monitoring, daily PVTs, and POMS captured recovery.

Results: Actigraphy-defined sleep time increased from baseline (M = 7.69 \pm 0.50) to fragmentation (M = 8.36 hr \pm 0.55; p < .001), while sleep efficiency decreased (M = 90.9% \pm 3.29, M = 83.8% \pm 2.52, respectively; p < .001). PVT lapses increased significantly during the week after fragmentation (M = 2.72 \pm 1.76) compared to baseline (M = 1.74 \pm 1.74; p = .022). Following fragmentation, mood disturbance (M = 9.55 \pm 8.92; M = -1.00 \pm 7.10; p < .05) increased.

Conclusion: In addition to establishing feasibility of a functional model, these data show that a single simulated night of postpartum sleep fragmentation is sufficient to cause poorer mood and PVT performance, despite increased total sleep time. These findings are the first to establish a causal effect of sleep fragmentation on previously reported poor daytime outcomes during the postpartum period. 6-sulphatoxymelatonin, MSLT scores, and sleep architecture will be available by June.

Support (If Any): West Virginia University's Eberly College of Arts and Sciences Doctoral Student Research Fund; West Virginia University Department of Psychology Student Research Fund.

0253

SUSTAINED WAKEFULNESS AND VISUAL ATTENTION: MODERATION BY CHRONOTYPE

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Introduction: Attentional networks have been shown to be sensitive to total or partial sleep deprivation. However, evidence to date is inconsistent and may be accounted for, for example, by differences in tiredness/sleepiness or chronotype. Furthermore, no studies have examined the effects of sustained wakefulness over shorter time periods, not atypical on a daily basis for the general population (such as following 18 hours of sustained wakefulness), on visual attention.

Methods: 29 good sleepers completed measures of attention and tiredness/sleepiness at two time-points (time 1: 8 am—30 minutes following awakening; and time 2: 2 am—18 hours following sustained wakefulness). The Attention Network Test was used to examine the efficiency of three attentional networks—alerting, orienting and executive control/conflict. A 100-point visual analogue scale was used to measure tiredness, the Karolinska Sleepiness Scale to measure sleepiness, and the Horne & Östberg Morningness-Eveningness Questionnaire to measure chronotype.

Results: Tiredness and sleepiness increased from time 1 to time 2. However, there were no significant differences in any of attentional network scores at the two time-points. Also, there was no interaction between changes in tiredness/sleepiness and changes in attentional network scores. However, there was a significant interaction between time and chronotype on differences in orienting score ($F[1,24] = 4.28$, $p = .05$): the greater the tendency towards morningness, the greater the degree of change in orienting score from baseline to following sustained wakefulness, suggesting specific and localized effect of chronotype on the performance of orienting attentional network.

Conclusion: Our preliminary results suggest that, although attentional processes are largely preserved over 18 hours of sustained wakefulness, morning-types may be more sensitive in their ability to orient attention over this time period than evening-types. It is likely that this effect is driven by changes in circadian phase between morning- and evening-types. This is the focus of the on-going research project.

0254

EFFECTS OF SLEEP DEPRIVATION ON ATTENTION AND WORKING MEMORY: A META-ANALYSIS OF FUNCTIONAL MRI STUDIES

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Introduction: Sleep loss is a significant health concern in contemporary societies and sleep deprivation (SD) impairs a broad range of cognitive functions associated with attention and working memory. Using functional MRI with various experimental paradigms, a series of neuroimaging studies have showed that hypoactivation in fronto-parietal attention networks following sleep loss. However, it is unclear whether SD has a common detrimental effect on brain activation during attention and working memory tasks. Here we performed a meta-analysis using activation likelihood estimation (ALE) to identify the common effect of SD on brain activation during attention and working memory tasks.

Methods: We identified 13 SD fMRI studies using various attention tasks with a total of 219 participants and 11 SD fMRI studies using working memory tasks with a total of 260 participants, equaling 75 foci from attention tasks and 98 foci from working memory tasks for ALE analysis, in which reported foci in all single studies are modeled as Gaussian functions and pooled to create a statistical whole-brain image. To correct for multiple comparisons, we used a threshold of False Discovery Rate corrected $p < 0.05$ and a minimum cluster size of 400 mm³. After these two signal ALE analysis respectively, we did a conjunction analysis to identify the common brain areas which impaired by SD in both attention and working memory tasks thresholded at $p < 0.05$ FDR corrected and a minimum cluster size of 200 mm³.

Results: The ALE analysis on attention tasks revealed reduced brain activation in many brain areas following SD comparing with rested wakefulness, including bilateral parietal lobule, bilateral insula, medial frontal gyrus, right parahippocampal gyrus, and right precentral gyrus, while increased activation in bilateral thalamus. The similar analysis on working memory tasks revealed decreased activation in bilateral inferior occipital gyrus, left middle and superior occipital gyrus, left fusiform, right sub-gyral, left middle temporal gyrus and precuneus, while

increased activation in bilateral thalamus and uvula in cerebellum. The common brain areas impaired by SD were precuneus, superior parietal lobule and fusiform, while increased activation was shown in thalamus for both attention and working memory tasks.

Conclusion: Our findings suggest that sleep deprivation commonly reduce neural activation not only parietal attention area, but also in the visual region and precuneus. The increased thalamic activation may reflect a compensatory mechanism for reduced arousal level after SD.

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0255

SLEEP DEPRIVATION EVOKED CHANGES IN THE TRANSCRIPTOME

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Introduction: Several kinds of comprehensive studies including microarray and proteome analysis in sleep-wake regulation have been reported. However, a more rigorous assessment of the transcriptome, affected by sleep deprivation (SD) may prove informative. RNA-seq analysis can provide a view of all changes in coding RNA, occurring in association with SD. Furthermore, emerging evidence indicates that the transcripts of genomes are complex and include functional non-coding sequences of RNAs, involved in the regulation of gene expression. We applied an in-depth, RNA-seq analysis and compared expressed transcripts under control and sleep deprived (SD) conditions in mice.

Methods: Using RNA-seq technique (illumina), we compared changes of transcripts in frontal and temporal cortex (FC and TC) from non-SD as a control, 4-h SD, and 2-h recovered sleep C57BL/6 mice, controlled for circadian phase. SD was maintained for 4 hrs from ZT0-4, and then spontaneous recovery sleep was allowed for 2 hrs from ZT4-6. RNAs were extracted from FC and TC at ZT4 and ZT6, pooled of three biological replicates for all groups, and used for experiments. A threshold of 1-fold change (2X) was chosen to select transcripts. Differentially expressed transcripts identified by RNA-seq analysis were evaluated by quantitative RT-PCR.

Results: All transcripts analyzed showed five or more reads for each biological replicate. Based on that, RNA-seq analysis identified 229 and 359 transcripts increased and decreased in SD condition, respectively, in FC. A more extensive analysis of sleep specific transcripts in FC and TC is currently ongoing.

Conclusion: These results are consistent with modulation of many transcripts involved in synaptic strength in the SD condition. However, many other functions must be affected as indicated by numerous non-synaptically related transcript expression changes already identified in our analysis.

0256

CHANGES IN ADENOSINE SIGNALING IN THE BASAL FOREBRAIN DURING POST-NATAL DEVELOPMENT

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Introduction: Evidence suggests that sleep-related activity of preoptic area neurons is modulated by adenosine (AD), a key regulator of sleep homeostasis in adult brain. Our findings suggest that functional emergence of preoptic sleep-promoting neurons contributes to the maturation

of sleep homeostasis. However, nothing is known about the role of AD in sleep maturation. We assessed changes in production of AD in the basal forebrain (BF) across postnatal days 20-30 (P20-P30), an important period for sleep maturation, and studied the effect of AD ICV injection on sleep homeostatic responses.

Methods: In Experiment 1, P19 and P28 rats (n = 3/group) were implanted with EEG/EMG electrodes and unilateral guide cannula for microdialysis probes targeting the BF. Beginning at ZT0, dialysate from the BF was collected over consecutive 30 min epochs of 1-h baseline, 3-h SD and 2-h recovery sleep (RS). In Experiment 2, P19 rats were implanted with EEG/EMG electrodes and a guide cannula targeting the lateral ventricle for ICV drug microinjection. A 3-h SD protocol accompanied by EEG/EMG recordings began at ZT1. At ZT3, rats were ICV injected with either AD (1 nmol/5 microliter) or equal volume of saline (n = 3/group) and the SD continued for 1 more hour followed by a 2-h RS.

Results: SD-related increases (compared to baseline, 100%) in AD levels in the BF were seen in P30 (SD: 222 ± 9%; RS: 121 ± 30%), but not P22 rats (SD: 99 ± 6%; RS: 89 ± 10%). Injection of AD resulted in significant decreases of wake time (11 ± 1.2 vs. 46 ± 3.6) and increases of both NREM (70 ± 3.4 vs. 55 ± 3.8) and REM (23 ± 2.3 vs 11 ± 0.8) sleep, compared to control conditions.

Conclusion: These findings support our hypothesis that developmental increases in wake-related production of AD in the BF parallel functional maturation of preoptic hypothalamus suggesting that these two critical sleep-regulatory mechanisms are involved in the maturation of sleep homeostasis.

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0257

DYNAMICS OF AN ADENOSINE-RECEPTOR-BASED MODEL OF SLEEP HOMEOSTASIS FOR ACUTE AND CHRONIC SLEEP RESTRICTION

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Introduction: Chronic sleep restriction in humans results in a progressive accumulation of cognitive impairments on a timescale of weeks or longer. The physiological mechanisms that underlie this phenomenon are unknown. Acute sleep deprivation causes a temporary increase in adenosine concentration in the brain, whereas chronic sleep restriction induces up-regulation of adenosine receptors. The change in adenosine receptor density has been proposed as a plausible mechanism underlying the long timescale accumulation of cognitive deficits, due to increased inhibition from adenosine.

Methods: We developed a mathematical model of adenosine concentration and adenosine receptor density that can be used to explore how this system responds to different sleep/wake patterns. The model includes short timescale kinetics for binding and unbinding of adenosine molecules with A1 receptors, changes in adenosine concentration in response to an imposed sleep/wake cycle, and long timescale changes in adenosine receptor density in response to changes in adenosine concentration. The density of bound receptors is then used as a proxy for sleep homeostatic pressure in a model of sleep and cognitive performance under conditions of chronic sleep restriction and recovery.

Results: When the dynamics of the model were explored, we found a physiologically reasonable parameter set. In this regime, the model was used to simulate changes in performance on the psychomotor vigilance task during chronic sleep restriction (4, 6, and 8 hours in bed for 14 days) and fitted to experimental data. The model was also used to simu-

late changes in sleep duration during recovery sleep (14 hours in bed) for 28 days following mild chronic sleep restriction.

Conclusion: Dynamics of the adenosine receptor system can plausibly account for the effects of chronic sleep restriction on vigilant performance, as well as sleep duration during recovery.

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0258

CHRONIC SLEEP RESTRICTION INCREASES SIRT1 IMMUNOREACTIVITY IN THE RAT BRAIN

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Introduction: Sirtuin 1 (SIRT1), a member of the sirtuin family of protein deacetylases, has diverse cellular functions, including protection against various metabolic challenges. Recent evidence suggested that SIRT1 has neuroprotective properties in wake-active neurons. To determine whether SIRT1 is induced in response to chronic sleep restriction (CSR), we examined SIRT1 immunoreactivity in the rat brain during and after the “3/1” protocol of CSR (continuous cycles of 3 h of sleep deprivation using slowly rotating wheels, followed by 1 h of sleep opportunity) for 99 h. We previously showed that this protocol initiated both homeostatic and adaptive changes in sleep measures and attention performance, and induced the transcription factors FosB/ Δ FosB.

Methods: Three groups of adult male Wistar rats were used ($n = 2$ /group): 2 CSR groups were housed in motorized activity wheels and underwent the 3/1 protocol for 27 h (SR2) or 99 h (SR5). A locked wheel (LW) control group was housed in stationary wheels. Following perfusion at the end of the experiment, brains were processed for SIRT1 immunohistochemistry.

Results: SIRT1 immunoreactivity was localized to cell nuclei. In the LW control group, SIRT1 staining was generally low, except for intense labeling in the hippocampal dentate gyrus, and hypothalamic regions including the arcuate nucleus. In the SR2 and particularly SR5 group, intense SIRT1 immunoreactivity was seen in the cerebral cortex and several sleep/wake-regulatory and autonomic regions, including basal forebrain nuclei, median preoptic nucleus, tuberomammillary nucleus, locus coeruleus, parabrachial nuclei, and paraventricular hypothalamic nucleus. The neurochemical phenotypes of SIRT1-positive neurons in sleep/wake regions are currently under investigation.

Conclusion: These preliminary results indicate an increase in SIRT1 immunoreactivity in the cortex and select sleep/wake and autonomic systems following 27 and 99 h of sleep restriction in rats. The induction of SIRT1 may contribute to the mechanisms underlying allostatic adaptation to CSR, possibly through SIRT1's neuroprotective function.

Support (If Any): CIHR.

0259

EFFECTS OF CHRONIC SLEEP RESTRICTION ON CARDIAC MEASURES AND BODY TEMPERATURE IN RATS

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Introduction: Chronic sleep restriction (CSR) has been identified as a risk factor for cardiovascular diseases. Short sleep duration (< 4.5 h per night) has been associated with increased heart rate (HR), body temperature (BT) and sympathetic tone. To study the cardiac impacts of CSR and underlying mechanisms, we conducted continuous monitoring of electrocardiogram (ECG) and BT in rats before, during and after a “3/1” protocol of CSR. This protocol uses cycles of 3 h of sleep deprivation (using slowly rotating wheels) followed by 1 h of sleep opportunity con-

tinuously for 4 days. We previously showed that this protocol initiated both homeostatic and allostatic (adaptive) changes in sleep parameters and psychomotor vigilance task performance.

Methods: Adult male Wistar rats ($n = 6$) were implanted with biosignal transmitters to monitor ECG, BT and motor activity continuously during a 2-day baseline period, 4 days of 3/1 protocol, and a 7-day recovery period. Transthoracic echocardiography was also conducted before and after the 3/1 protocol to assess cardiac morphology and performance.

Results: HR was increased by 10% from baseline levels on day 1 of CSR, remained elevated for the rest of CSR, and returned to baseline levels by day 2 of recovery. BT gradually increased during CSR, returning to baseline levels by day 5 of recovery. Echocardiographic data ($n = 1$; in progress) showed signs of cardiac hypertrophy (25% increase in ventricular wall thickness compared to baseline values) one week after CSR. Time and frequency domain analyses of ECG signals are in progress.

Conclusions: These preliminary data indicate that the 3/1 CSR protocol for 4 days induced a sustained increase in HR and BT, and that it takes 2-5 days for these measures to return to baseline levels. These recovery time courses tend to be slower than for most sleep parameters and sustained attention performance previously reported using the same CSR protocol.

Support: CIHR.

0260

AYAHUASCA AND SLEEP LOSS MAY MODULATE SEXUAL RESPONSE IN MALE RATS

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Introduction: The ingestion of the beverage Ayahuasca usually occurs nocturnally and is often associated with sleep deprivation. The purpose of the present study was to characterize the acute effects of Ayahuasca upon the sexual response of sleep deprived male rats.

Methods: Sexually experienced male Wistar rats were submitted to a paradoxical sleep deprivation (PSD) protocol for 96 h or the equivalent time period in home cage (CTRL) animals. After this period, either saline or Ayahuasca drink (250, 500 and 1000 $\mu\text{g mL}^{-1}$) was administered by gavage and sexual behavior and hormonal concentrations were measured.

Results: Ayahuasca alone significantly decreased sexual performance at all doses. However, in sleep-deprived rats the lower dose increased sexual performance while the intermediate dose produced a detrimental effect on sexual response compared to the CTRL rats at the same dose. Regarding the hormonal analyses, lower testosterone concentration was observed in sleep-deprived saline rats in relation to the CTRL group. Progesterone was significantly lower only in PSD rats at the dose 500 $\mu\text{g mL}^{-1}$ compared with CTRL-500 $\mu\text{g mL}^{-1}$ group. Corticosterone was unchanged among the groups evaluated.

Conclusion: Our results suggest that Ayahuasca intake markedly impaired sexual behavior alone, but, when combined with sleep deprivation, had significant, but heterogeneous, effects on male sexual performance.

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0261

ANXIETY-LIKE EFFECTS OF META-CHLOROPHENYLPIPERAZINE IN PARADOXICALLY SLEEP-DEPRIVED MICE

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Introduction: Chlorophenylpiperazines (CPP) are psychotropic drugs used in nightclub parties and are frequently used in a state of sleep deprivation, condition which can potentiate the effects of psychoactive drugs. This study aimed to investigate the effects of sleep deprivation and sleep rebound (RB) on anxiety-like measures in mCPP-treated mice using the open field test.

Methods: We first optimized our procedure by performing dose-effect curves and examining different pretreatment times in naïve male Swiss mice. Subsequently, a separate cohort of mice underwent paradoxical sleep deprivation (PSD) for 24 or 48 h. In the last experiment, immediately after the 24 h-PSD period, mice received an injection of saline or mCPP, but their general activity was quantified in the open field only after the RB period (24 or 48 h).

Results: The dose of 5 mg/mL of mCPP was the most effective at decreasing rearing behavior, with peak effects 15 min after injection. PSD decreased locomotion and rearing behaviors, thereby inhibiting a further impairment induced by mCPP. Plasma concentrations of mCPP were significantly higher in PSD 48 h animals compared to the non PSD control group. Twenty-four hours of RB combined with mCPP administration produced a slight reduction in locomotion.

Conclusion: Our results show that mCPP was able to significantly change the behavior of naïve, PSD, and RB mice. When combined with sleep deprivation, there was a higher availability of drug in plasma levels. Taken together, our results suggest that sleep loss can enhance the behavioral effects of the potent psychoactive drug, mCPP, even after a period of rebound sleep.

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0262

SLEEP DEPRIVATION IMPAIRS THE EXTINCTION OF COCAINE-INDUCED ENVIRONMENTAL CONDITIONING IN MICE

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Introduction: Persistence of a drug-environment conditioning induced by repeated psychostimulant treatment is thought to play a key role in the addictive cycle. In addition, sleep disorders are a common feature in patients with addictive disorders. Sleep deprivation shares similar neurobiological effects with psychostimulants. Therefore, we investigated whether sleep deprivation would impair the extinction of previously established conditioning between the drug effect and the environmental cues.

Methods: Four cohorts of male adult mice underwent a behavioral sensitization procedure pairing drug (cocaine at 15 mg/kg, i.p.) or saline with environment (open-field apparatus). The extinction of conditioned locomotion was evaluated after control (home-cage maintained) or sleep deprivation (gentle handling method for 6 h) conditions.

Results: Sleep deprivation both postponed the initiation and impaired the completeness of extinction of the conditioned locomotion promoted by previous drug-environment conditioning in cocaine-sensitized animals. Importantly, while the cocaine control group required 5 free-drug sessions of exposure to the open-field apparatus to complete extinction of conditioned locomotion, the cocaine pre-treated group that experienced sleep deprivation before each extinction session still significantly differed from its respective control group on Day 5 of extinction.

Conclusion: The possibility that the sleep condition can influence the extinction of a long-lasting association between drug effects and environmental cues may represent the basis for a clinically relevant phenomenon.

Support (If Any): AFIP, FAPESP #2011/16580-0, CNPq, CAPES, FADA.

0263

VALIDATION OF A WORKLOAD-SENSITIVE MATHEMATICAL MODEL OF THE TEMPORAL DYNAMICS OF PERFORMANCE

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Introduction: Current models of sleep/wake regulation posit that sleepiness and performance are affected by prior wake duration regardless of the nature of waking activities. However, recent experimental and theoretical evidence suggests an effect on performance of prior cognitive workload. We incorporated this evidence into a state-of-the-art model of the temporal dynamics of performance.

Methods: The mathematical model of McCauley et al. (2013) predicts performance (PVT lapses) based on homeostatic and allostatic processes of sleep/wake regulation modulated by circadian rhythm. We added high workload as an additional modulator of the homeostatic and allostatic processes, using one free parameter to represent the magnitude of the effect. For parameter estimation we used PVT lapses observed during a 12-day laboratory experiment in which N = 21 healthy adults were subjected to 36 h sleep deprivation three times, followed each time by two recovery nights. Subjects performed a cognitive test battery every 2 h; the battery was 30 min long (standard workload) during two of these sleep deprivations and 60 min long (high workload) during the other sleep deprivation (in randomized, counterbalanced order). PVT lapses increased progressively during the sleep deprivation with high workload relative to the sleep deprivations with standard workload. For model validation we used PVT lapses observed during a daytime high-fidelity, moving-base flight simulator experiment in which N = 24 active-duty commercial pilots carried out a 9 h duty day with a single-segment (long-range) flight and also a 9 h duty day with multi-segment (i.e., five short-range) flights (in randomized, counterbalanced order). Take-offs and landings were considered high workload. PVT performance was measured 10 times during each duty day, and PVT lapses increased progressively during the multi-segment duty day compared to the single-segment duty day.

Results: The estimate (\pm s.e.) for the free workload parameter was 1.16 (\pm 0.11). Model validation on the difference in PVT lapses between the multi-segment and single-segment duty days in the flight simulator experiment showed reduced prediction error (mean squared error), relative to the original model without workload effect, from 0.179 to 0.036 ($\chi^2 = 16.0$, $P < 0.001$).

Conclusion: These results provide the first evidence of predictive validity of a novel, workload-sensitive, mathematical model of performance. This model may be useful for comparing relative performance in daytime duty schedules in commercial airline operations.

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0264

VALIDATION OF SMARTPHONE-BASED AND IPAD-BASED PSYCHOMOTOR VIGILANCE TESTS

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Introduction: In this total sleep deprivation (TSD) study, a smartphone-based Psychomotor Vigilance Test (PVT) and an iPad-based PVT, each 3 min in duration, were validated against a standard 10 min laptop-based PVT.

Methods: 16 subjects (ages 22-40; 9 females) completed a 5-day (4-night) in-laboratory study. After adaptation and baseline days (each 10 h TIB; 22:00-08:00), subjects underwent a 38 h TSD period, followed by a recovery night. Subjects practiced each PVT version during the adaptation day. During the baseline day and the TSD period, subjects performed each PVT version every 3 h. Test blocks consisted of the 3 min smartphone PVT, a 10 min break, the 10 min laptop PVT, a 20 min break, and the 3 min iPad PVT. Number of lapses, defined as reaction times (RTs) > 500 ms for the 10 min laptop PVT and > 355 ms for the 3 min smartphone and iPad PVTs, served as the primary outcome measure for validation purposes. Mean RT and number of false starts were also analyzed. Statistical analysis involved mixed-effects analysis of variance (ANOVA) of number of lapses, with test blocks as fixed effect and subjects as random effect on the intercept. Validation of the 3 min PVTs involved mixed-effects analysis of covariance (ANCOVA) of lapses on the 10 min laptop PVT, with subjects as random effect on the intercept and lapses on the 3 min smartphone or iPad PVT as covariate.

Results: For number of lapses and mean RT, there were significant effects of test block for all three versions of the PVT ($F \geq 5.2$, $P < 0.001$). There was significant covariance between lapses on the 10 min laptop PVT and lapses on the 3 min smartphone PVT ($r = 0.621$, $P < 0.001$) and the 3 min iPad PVT ($r = 0.638$, $P < 0.001$). Likewise, there was significant covariance between mean RT on the laptop PVT and mean RT on the smartphone PVT ($r = 0.563$, $P < 0.001$) and the iPad PVT ($r = 0.463$, $P < 0.001$). For number of false starts, there were significant effects of test block for all three versions of the PVT ($F \geq 2.2$, $P < 0.02$), but false starts were rare (average < 2 per test bout) regardless of PVT version and showed no significant covariance among PVT versions.

Conclusion: These results indicate that the 3 min smartphone PVT and 3 min iPad PVT are valid instruments for measuring fatigue during acute TSD. Compared to the standard 10 min PVT on the laptop, the 3 min PVTs were less sensitive due to shorter test duration, but this was partially mitigated by using a 355 ms threshold for lapses on the 3 min PVTs.

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0265

AN IMPROVED METHOD FOR THE DETECTION OF DROWSY DRIVERS USING LANE HEADING DIFFERENCE

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Introduction: Although recent advances in technology have contributed to the development of drowsy driving detectors, research suggests that better single indicators of drowsy driving behaviors are needed. The purpose of the current research is to propose utilizing the root mean square error of vehicle heading (i.e., Yaw) as an improved measure of drowsy driving.

Methods: Participants were 20 students (20.55 ± 2.4 years; 11 females). During 26 hours of sleep deprivation, participants completed a variety of tasks across five testing sessions (8:00-10:30 pm, 10:45-1:15 am, 1:45-4:15 am, 4:30-7:00 am, and 7:30-10:00 am). Participants completed three tasks as indicators of sleep deprivation and fatigue: PVT to index reaction time, an oculomotor fatigue measure (FIT) to index eye saccade velocity change, and a driving simulator task. Performance on the driving simulator was determined using two methods consisting of four models: the common metric of standard deviation of lane position, using raw and absolute values; and the less common metric of root mean square error of differences between the vehicle heading and the lane heading, using raw and absolute values.

Results: Repeated-measures ANOVAs were completed to examine performance across the five testing sessions for each task. There was a significant main effect for testing sessions ($p < .001$) indicating that performance decreased across the night for all tasks. Out of the four

models used to assess the driving task, the new method of root mean square error of heading differences using absolute values was a stronger indicator of poor performance than the other three models.

Conclusion: The proposed method of analyzing vehicle heading was best at detecting poor driving performance due to sleep deprivation. These findings suggest that the new model may detect dangerous driving behavior more accurately and at lower levels of drowsiness than other methods of detection used in technology currently.

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0266

UPPER AIRWAY OBSTRUCTION INDUCES ABNORMAL SLEEP DYNAMICS IN JUVENILE RATS

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Introduction: Conventional scoring of sleep provides little information about the process of transitioning between vigilance-states. We used the state space technique to explore whether the state instability in rats with chronic upper airway obstruction (UAO) reflects abnormal sleep/wake states, faster movements between states, or abnormal transitions between states.

Methods: The tracheae of 22-day-old Sprague-Dawley rats were surgically narrowed to increase upper airway resistance with no evidence for frank obstructed apneas or hypopneas; 24-h electroencephalography (EEG) of sleep/wake recordings of UAO and sham-control animals was analyzed using state space technique. This non-categorical approach allows quantitative and unbiased examination of vigilance-states and state transitions. Measurements were performed 2 weeks post-surgery at baseline and following administration of ritanserin (5-HT₂ receptor antagonist) the next day to stimulate sleep.

Results: UAO rats spent less time in deep (delta-rich) slow wave sleep (SWS) and near transition zones between states. State transitions from light SWS to wake and vice versa and microarousals were more frequent and rapid in UAO rats, indicating that obstructed animals have more regions where vigilance-states are unstable. Ritanserin consolidated sleep in both groups by decreasing the number of microarousals and trajectories between wake to light SWS, and increasing deep SWS in UAO.

Conclusion: State space technique enables visualization of vigilance-state transitions and velocities that were not evident by traditional scoring methods. This analysis provides new quantitative assessment of abnormal vigilance-state dynamics in UAO in the absence of frank obstructed apneas or hypopneas.

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0267

A COMPARATIVE ANALYSIS OF MULTIPLE ARTIFACT REJECTION METHODS

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Introduction: It is widely assumed that EEG artifact rejection should be utilized prior to application of quantitative analysis methods (e.g., power

spectral analysis). This assumption has not, however, been empirically tested. If artifacts occur relatively infrequently relative to hundreds or thousands of analytic windows, then their identification and rejection may not be necessary. The present study evaluates whether any of three artifact rejection strategies produces spectral profiles that are significantly different from raw EEG data.

Methods: Data from n = 90 subjects were used (n = 60 Primary Insomnia and n = 30 controls matched on sex, age, BMI, and education). Power spectral analysis of 4-second windows was performed using C3-A2 placement, with 128 Hz sampling and high-pass/low-pass filters set at 0.3 Hz/100 Hz. Three artifact rejection methods were compared to raw data using average Stage 2 and NREM/REM power spectral voltages. The first method utilized a 3-minute moving window that rejected epochs containing values that were 4*median in the 26.25-32 Hz frequency range (Brunner et al., 1996). The second method employed the same algorithm with an Alternate range (45-64 Hz). The final method employed Visual artifact rejection of 30-second windows.

Results: All three artifact rejection methods resulted in decreased power across all frequency bands for NREM/REM and Stage 2, compared to raw data (p < 0.0001). Additionally, methods generally differed from each other. Visual rejected more data than the Brunner and Alternate methods (by 12.9% and 11.7% respectively; p < 0.0001). Across methods, more epochs were rejected in NREM versus REM (p < 0.001), but methods did not differ from each other.

Conclusion: The systematic application of the artifact rejection procedures assessed here produced reliable differences that are small in absolute magnitude but statistically significant. A stronger test of the utility of artifact rejection would be whether its application enhances the ability to detect group membership or the effects of experimental manipulations. Analyses are ongoing regarding group differences.

0268

COMPARING LINEAR/NONLINEAR SIGNAL PROCESSING AND MACHINE LEARNING ALGORITHMS FOR ONLINE SINGLE-EEG BASED SLEEP STAGING

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Introduction: Recent research evidence indicates that modulating brain activity during sleep via peripheral intervention at specific sleep stages can be beneficial in a wide range of contexts including memory consolidation and depression relief. To verify the validity of such interventions in practice requires automated means for online sleep staging with low latency which allows timely intervention. In this study we focus on achieving online automatic sleep staging on the basis of a single EEG signal. We consider several alternatives for: a) the EEG signal, b) the signal processing techniques to extract features characterizing sleep stages, and c) machine learning methods.

Methods: EEG data from 10 subjects (5F; age 21.9 ± 0.5 years) was used in this study. The data includes six EEG signals (F3-A2, F4-A1, C3-A2, C4-A1, O1-A2, and O2-A1), and the manually annotated hypnogram on the basis of 30-second long epochs. Spectral-domain, time-domain, linear, and nonlinear feature extraction signal processing algorithms were considered. Three state-of-the-art machine learning approaches (random forests, neural networks, and support vector machines) were assessed. The classification performance obtained for each combination of EEG signal, signal processing, and machine learning algorithms was assessed using the kappa statistic (standard in sleep staging research). A variable duration of the epoch to decide on the sleep stage was also considered. To do this the hypnogram was oversampled by a factor of 5 (6-second long epochs).

Results: Frontal EEG signals led to the best classification performance. Spectral domain features resulted in a slightly higher performance than time-domain features yet the combination yields the best result. The performance increases with the epoch duration. A substantial agreement ($\kappa = 0.57$) is already reached for an epoch duration of 18-seconds. Random forests led to the highest performance (average $\kappa = 0.66$ for 30-second long epochs) followed by the recurrent neural network (average $\kappa = 0.61$ for 30-second long epochs).

Conclusion: The use of random forests and spectral-temporal features extracted from a single EEG signal enables online sleep staging with a substantial accuracy as characterized by a κ value of 0.66.

0269

EVALUATION OF MICRO SLEEP ARCHITECTURE IN PATIENTS WITH FIBROMYALGIA UTILIZING A NOVEL COMPUTER ASSISTED SCORING SYSTEM

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Introduction: Non restorative sleep (NRS), as defined by alpha and beta wave intrusion into sleep, has not been easily quantified using any computer-assisted scoring system (CASS), and tedious at best when hand-scored. The Michelle scoring system (MSS) adds to the current sleep macro-architectural parameters a new algorithmic value called ORP (odds ratio product), which is the probability that the power of spectrum of EEG patterns analyzed in three second intervals reflects a wake pattern. ORP is determined in 3-second consecutive intervals. Average ORP can be determined over specific times or sleep stages. This measure of sleep stability detects arousal-like changes which have generally been ignored in Rechtschaffen & Kales. The ORP index ranges from 0 to 2.5 with higher values reflecting more sleep disruption. ORP correlation with alpha might simplify scoring and lead to a better evaluation of NRS in clinical conditions such as Fibromyalgia.

Methods: Ten patients diagnosed with fibromyalgia and reporting poor sleep quality underwent polysomnography as part of a fibromyalgia clinical trial. Baseline recordings were manually scored and scored by MSS to obtain average ORP during rapid-eye-movement (REM) and non-REM sleep. Percent of non-REM epochs with ≥ 3 seconds of alpha-wave intrusion (PNA) was manually derived.

Results: Seventy percent of patients had elevated levels ($\geq 30\%$) of non-REM epochs with alpha intrusions (range: 14.3-100%). Average ORP values ranged from 0.49 to 1.39 during non-REM sleep (0.73 ± 0.29) and correlated with PNA values ($r = 0.65$, $p = 0.041$). REM ORP values ranged from 0.36 to 1.35 ($n = 9$; 0.85 ± 0.32) and showed a very strong correlation with non-REM alpha intrusions ($r = 0.95$, $p < 0.0001$).

Conclusion: These results suggest that ORP can be a practical predictive coefficient of NRS, and a useful tool in studying disrupted sleep in a variety of disease states.

Support (If Any): The study was supported by Forest Research Institute.

0270

VALIDATION OF A PROTOTYPE WRIST ACTIGRAPH DEVELOPED AS PART OF A PHYSIOLOGICAL AND ENVIRONMENTAL SENSOR ARRAY FOR USE IN NAVAL OPERATIONS

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Introduction: A new wrist actigraph prototype developed as part of a wrist-worn physiological and environmental sensor array for use in Naval

operations (Pulsar Informatics, Philadelphia, PA) was validated against a commercially available wrist actigraph serving as the validation standard (Actiwatch 2, Respironics, Bend, OR) during a laboratory experiment. Here we report on the results of this validation with regard to the estimation of sleep duration, sleep latency and intermittent wakefulness.

Methods: 16 healthy subjects (ages 22-40; 9 females) spent 5 consecutive days in a sleep laboratory. They had an adaptation day and a baseline day, each with a nocturnal sleep opportunity, then a 38 h period of total sleep deprivation followed by a nocturnal recovery sleep opportunity. All three sleep opportunities were 10 h TIB (22:00-08:00). During scheduled wakefulness, subjects completed a cognitive performance test battery every 3 h. Between test bouts, subjects were free to engage in non-vigorous activities such as reading or playing board games—they were mostly sedentary and did not leave the laboratory. Throughout the study the subjects wore the new actigraph prototype and the validation standard actigraph side by side on the wrist of their non-dominant arm, with the new actigraph prototype closest to the hand. For both devices, activity counts in 1 min bins were extracted over the scheduled TIB periods. In addition, sleep duration, sleep latency and intermittent wakefulness were assessed over the scheduled TIB periods using the respective manufacturer-provided proprietary algorithms.

Results: Mixed-effects analysis of covariance (ANCOVA) revealed that the level of agreement between the new actigraph prototype and the validation standard actigraph was high for 1 min-bin activity counts ($r = 0.87$, $F > 1000$, $P < 0.001$), sleep duration ($r = 0.91$, $F = 150$, $P < 0.001$) and intermittent wakefulness ($r = 0.93$, $F = 201$, $P < 0.001$), and moderate for sleep latency ($r = 0.55$, $F = 13$, $P = 0.001$).

Conclusion: This study provided evidence of the validity of a new actigraph prototype developed as part of a wrist-worn physiological and environmental sensor array for use in naval operations in terms of wrist activity counts and the estimation of sleep duration and intermittent wakefulness. Furthermore, given that the detection of wrist movements was found to be reliable, it is likely that refinement of the manufacturer's algorithm for the assessment of sleep variables would result in improved estimates of sleep latency.

Support (If Any): ONR grant N00014-13-C-0063.

0271

VALIDATION OF A SMART PHONE PSYCHOMOTOR VIGILANCE APPLICATION: PRELIMINARY DATA

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Introduction: Recent advances in smartphone technologies have led to the development of new and easily accessible tools, which can measure alertness and cognitive performance during various sleep deprivation (SD) conditions. The aim of the present study is to validate the reaction time test (RTT) of sleep-2-Peak (s2P), a new smartphone application designed to measure vigilance.

Methods: 10 subjects (4 men, 6 women; aged 18 to 23) underwent 35 hours of total SD. Every 2 hours from 10 AM (day 1) to 6 PM (day 2), each participant had to complete a 3 min version of both s2P and Psychomotor Vigilance Task-192 (PVT-192) (counterbalanced), along with the KSS, the SSS, and a VAS of sleepiness. Correlations between each RTT and the 3 subjective measures of sleepiness (SMS) were computed. In order to verify if both RTTs were similarly related to the SMS, T-Tests were calculated using the correlations obtained. Correlations were then computed between both RTT performances (divided in blocks of 6 hours).

Results: Results showed significant correlations between s2P and KSS, SSS and VAS ($r = .38$; $r = .44$, $r = .43$, $p < .01$, respectively) and between

PVT-192 and KSS, SSS and VAS ($r = .43$; $r = .45$, $r = .45$, $p < .05$). Finally, results demonstrated a significant relationship between performances on both RTTs for the following time blocks: 2-4-6 PM ($r = .52$, $p < .05$), 8 PM-10 PM-12 AM ($r = .47$, $p < .05$), 2-4-6 AM ($r = .73$, $p < .01$), 8 AM-10 AM-12 PM ($r = .73$, $p < .01$), and 2-4-6 PM ($r = .69$, $p < .01$).

Conclusion: These results suggest that s2P may be as efficient as the classic PVT-192 when it comes to measuring variations in vigilance in a SD condition. However, more subjects need to be tested, and other variables including % omissions and % commissions need to be analysed in order to confirm the validity of s2P.

0272

ANALYSIS OF MEAN TRANSCUTANEOUS CAPNOGRAPHY IN CONSECUTIVE NORMAL PATIENTS UNDERGOING POLYSOMNOGRAPHY

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Introduction: Transcutaneous capnography is a noninvasive method useful for analysis of the behavioral tendency of transcutaneous CO_2 pressure (PtcCO_2) in patients undergoing polysomnography, to evaluate respiratory sleep disorders.

Methods: One hundred seventy-nine patients who underwent polysomnography with simultaneous PtcCO_2 measurement were assessed by means of a transcutaneous capnograph. The group classified as normal ($N = 53$) presented a apnea/hypopnea index (AHI) < 5 events/per hour of sleep and their age groups varied between 7 and 76 years of age.

Results: Global mean values of PtcCO_2 in the normal group had a Gaussian distribution that varied between 33.1 and 50.0 mmHg (SD 4.363).

Conclusion: Such findings allowed the establishment of normative PtcCO_2 values for normal individuals.

0273

THE VARIATION BETWEEN NIGHTS SHOULD BE TAKEN INTO ACCOUNT WHEN INVESTIGATING THE RELATIONSHIP BETWEEN SUBJECTIVE AND OBJECTIVE SLEEP MEASUREMENTS

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Introduction: Objective sleep measurements are expected to be predictors of the subjective sleep quality. The present study investigates whether higher correlations between subjective and objective sleep measures will be found when the difference between two nights is considered rather than one specific night.

Methods: Data from the European project SIESTA was used, including 157 healthy controls (hc), 26 participants with a mental disorder (md) and 69 participants with a physiological illness (pi) (aged between 20-95). They spent two consecutive nights in the sleep laboratory and filled out the self-rating questionnaire for sleep and awakening quality (SSA). Spearman's rho correlation analyses were conducted: one analysis with the difference between the two nights of the objective R&K values and the subjective sleep ratings (night 2 – night 1) and another analysis with the absolute values of each night separately.

Results: Higher correlations were found when taking the sleep quality sub score instead of the total score of the SSA. For the healthy controls and the physiological illness group, the highest significant correlations were found when considering the difference between the nights. These correlations were between subjective sleep quality and wake time (hc, $r = .427$, $p < .001$) (pi, $r = .609$, $p < .001$) and between subjective sleep

quality and sleep efficiency (hc, $r = -.418$, $p < .001$) (pi, $r = -.602$, $p < .001$). Conversely, in the mental disorder group a greater number of and more significant correlations were observed when looking at each night separately, with a remarkable correlation between subjective sleep quality and REM ($r = -.525$, $p = .006$) (night 2).

Conclusion: Moderate to high correlations between SSA scores and physiological measures were found when considering the difference between the nights of the measurements in healthy controls and in the physiological illness group. However, for the mental disorder group the subjective sleep quality was mostly correlated to the duration of REM sleep on the second night.

0274

MULTIVARIATE INDIVIDUALIZED PREDICTION OF NEUROBEHAVIORAL IMPAIRMENT DUE TO SLEEP DEPRIVATION

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Introduction: Biomathematical fatigue models may accurately predict group-average neurobehavioral performance deficits in response to sleep deprivation, but trait individual differences—which have been shown to be substantial—are not adequately captured. Fatigue model predictions may be individualized efficiently using Bayesian forecasting, combining population means and between-subjects variances of model parameters (Bayesian priors) with subject-specific, task-specific performance measurements. However, in scenarios where data from the subject is sparse for the task at hand, it may not be feasible to obtain individualized predictions that reach acceptable levels of accuracy. Here we investigated whether secondary fatigue outcomes—e.g., performance measurements on another task or outcome variable—can improve the parameter individualization process.

Methods: We examined the case of two data sources for the individual: measurements on the outcome variable used for prediction in the fatigue model (primary variable) and measurements on another fatigue outcome variable (secondary variable). Complicating matters, responses to sleep loss depend not only on the individual but also on the outcome variable considered. We therefore introduced between-subjects correlation in the Bayesian priors to account for the degree of covariance between outcome variables. We then combined the Bayesian priors with data from both the primary and secondary variables using the Bayesian forecasting method to make individualized predictions on the primary variable. We assessed how the accuracy of predictions depends on the number of measurements, the magnitudes of the individual differences, and the correlation between outcome variables.

Results: For a linear model, we derived equations to evaluate the contributions of measurements on the primary and secondary outcome variables to the accuracy of individualized predictions on the primary variable. We denoted the population between-subjects variances of the primary and secondary variables as δ_1^2 and δ_2^2 and their between-subjects correlation as ρ , the corresponding error variances as σ_1^2 and σ_2^2 , the number of measurements as m_1 and m_2 , and the cost of each of these measurements as c_1 and c_2 . It was found that the overall cost of model individualization to obtain a fixed level of accuracy, as defined by the mean squared error in the response η , is minimized by: $m_1 = [1/(\eta\sigma_1^2) - 1/(\delta_1^2(1-\rho^2))]/\sigma_1^2 + c_2^{1/2}\rho\sigma_1\sigma_2/(c_1^{1/2}\delta_1\delta_2(1-\rho^2))$ and $m_2 = \sigma_2[(c_1/c_2)^{1/2}\delta_2\sigma_1\rho - \delta_1\sigma_2]/(\delta_1\delta_2^2(1-\rho^2))$.

Conclusion: The equations we derived provide a path toward cost-effective individualization of predictions of neurobehavioral performance impairment due to sleep deprivation. Further work will extend the equations to nonlinear fatigue models.

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0275

RELIABILITY OF CAPTURING SLEEP DIARY DATA VIA WRIST WORN ELECTRONIC DEVICE

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Introduction: Paper sleep diaries are the gold standard for assessment of sleep continuity variables in clinical practice as well as research. In recent years web based programs via computer or hand held devices have shown promise in improving timeliness and accuracy of data collection. Actigraphy has also become a popular avenue of collecting objective measures of sleep. In this study, we proposed to assess the reliability of using a wrist worn electronic sleep diary that also includes actigraphy in comparison to collecting sleep diary data via paper diary.

Methods: The nested, prospective design included capturing two weeks of paper sleep diary, wrist worn electronic sleep diary, and actigraphy. Baseline covariate data included sex, age, race, ethnicity, years of education, Insomnia Severity Index (ISI) total score, PROMIS- 57 profile, Epworth Sleepiness Scale (ESS), and the Sleep Disorders Screening Questionnaire. Analysis strategies were descriptive as well as Pearson r correlations between calculated scores on sleep latency (SL), wake after sleep onset (WASO), number of awakenings (NWA), and sleep efficiency (SE) via the paper diary, electronic diary, and actigraphic data.

Results: Thirty-four participants were recruited from the community at large. 76% females, 79% white, mean age 37 (14), mean education was 2 years college, and household income 32% less than 30K/yr and 47% between 50-100K/yr. All subjects completed all study procedures. Significant correlations were found between actigraphy and electronic diary [SL: $r = .479$, $p = .007$], [WASO: $r = .424$, $p = .019$], [TST: $r = .721$, $p = .000$]. No significant correlations were found between actigraphy and paper diaries on SL, WASO, NWA, or TST.

Conclusion: Wrist worn electronic capture of sleep diary variables appears to be higher correlated with actigraphy data than does data collection via paper diaries.

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0276

A COMPARISON OF LOW, MEDIUM, AND HIGH WAKE THRESHOLD SETTINGS FOR ACTIGRAPHY SLEEP ONSET LATENCY AND TERMINAL WAKEFULNESS IN COLLEGE STUDENTS WITH AND WITHOUT INSOMNIA

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Introduction: Actigraphy is sensitive at detecting sleep, but not very specific. To increase wake specificity, several researchers have recommended using a low wake threshold setting. This is especially relevant for sleep parameters that measure wakefulness, i.e., sleep onset latency (SOL), wake time after sleep onset (WASO), and terminal wakefulness (TWAK). However, current software uses additional criteria to determine sleep onset and sleep offset, which may not accurately detect the

sleep/wake transition. The purpose of this study is to determine if SOL and TWAK values increase with a low wake threshold. We hypothesize that SOL and TWAK will not change based on the wake threshold.

Methods: Participants (N = 153) were 18-29 years old (M = 20.24 \pm 2.53), 58.8% female, and determined to have insomnia (n = 71) or healthy sleep (n = 82) based on a structured interview and questionnaires. They were instructed to report daily sleep diary data and press the actigraph event marker at bedtimes and risetimes. Time in bed intervals were manually set using this information. Sleep parameters were calculated based on low, medium, and high wake thresholds (20, 40, and 80 activity counts, respectively). We compared SOL and TWAK based on each wake threshold setting.

Results: Consistent with our hypothesis, SOL and TWAK did not change depending on the wake threshold setting. This finding held true for people with and without insomnia.

Conclusion: This suggests that Actiware sleep onset and offset criteria are not affected by the wake threshold setting. Although the low wake threshold setting has been recommended to increase specificity, this data suggests that the wake threshold setting only affects WASO because it does not affect SOL or TWAK. Future research should seek to increase actigraphy specificity for SOL and TWAK.

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0277

PRESCHOOLERS' NAPTIME BEHAVIOR: ACTIGRAPHY AND OBSERVER MEASURES

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Introduction: The goal of this study is to report on the characteristics of preschoolers' activities during either scheduled naptimes or during scheduled wake times (e.g., lunch, play) in preschool/daycare settings. Our objectives are two-fold: first, to determine how much sleep children experience in the preschool setting, and second, to determine the accuracy of experimenter observations relative to actigraphy.

Methods: We collected data from 14 children aged 37.1 to 60.8 months (mean 47.6 months), from three different preschools. Seven were assigned to the Sleep condition (data collected during regularly scheduled naptime), and 7 to the Wake condition (data collected when children were scheduled to be awake). We recorded their activity via: 1) actigraphy (Philips Actiwatch 2, worn on the non-dominant wrist), and 2) manual coding at 15-minute intervals by an experimenter. Experimenters recorded whether children appeared to be: sleeping, lying awake, playing quietly, playing actively, eating, or restless.

Results: Our results indicate first, that as Ward et al. (2007) found, children sleep during preschool naptime. All but one of the Sleep-assigned children slept for over 60% of naptime. Second, also like Ward et al., we find strong correlations between actigraphy and experimenter observation ($R^2 = .96$). (We also will provide insights about the optimal coding scheme for observers.)

Conclusion: That preschoolers sleep during naptime suggests that naptime should remain integral to the preschool routine. That there is a high correlation between actigraphy and experimenter observation suggests that experimenter observation alone may be a reliable measure. This broadens our abilities to collect such data in locations or populations for which actigraphy monitors are impractical (e.g., children with certain disorders who do not tolerate the watch, some cultures, poor populations where actigraphy monitors are cost-prohibitive). For many research and policy questions, such coarse measures may suffice, and equipment-free measures may be optimal.

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0278

DIFFERENTIATION OF CENTRAL AND OBSTRUCTIVE SLEEP APNEA BY FAST FOURIER TRANSFORM (FFT) ANALYSIS ON CARDIORESPIRATORY SIGNALS DETECTED BY A PIEZOELECTRIC SENSOR

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Introduction: We have been studying the feasibility of a noninvasive piezoelectric (PZT) sensor for sleep-disordered-breathing (SDB) screening, which may reduce the undiagnosed patients due to the lack of facilities equipped with a full polysomnography (PSG) system. In this study, we investigated the capability of the cardiorespiratory signal detected by the PZT sensor for separating between central and obstructive sleep apnea (CSA and OSA) by fast-Fourier transform (FFT) analysis.

Methods: After simultaneous overnight PSG and PZT-sensor recording with 27 inpatients, 8 and 19 were diagnosed as having CSA and OSA, respectively, according to the AASM standard by a trained expert. The PZT-sensor signal was recorded by a PSG system with 500 Hz sampling frequency. After the recording, representative 27 apnea epochs of duration of 11 s from 27 patients were analyzed by FFT with a window function of Hamming. The FFT analysis was performed by using a signal analysis software.

Results: A characteristic pattern in FFT results was observed in PZT signal of CSA in 5/8 patients; a clear peak appeared at around heart rate (HR \approx 1 Hz), which was followed by consecutive peaks (higher harmonic waves) until \sim 30 Hz. Relatively similar but inconsistent patterns were also observed in 6/19 OSA patients. On the other hand, the sum of power spectral density (PSD) of $<$ 0.6 Hz, which may indicate the power for respiratory effort during apnea, in CSA patients was significantly lower compared to that in OSA patients (1.2 ± 1.5 vs 172 ± 218 V²/Hz; $p = 0.003$); 3/19 of OSA patients had the power lower than the maximum of the CSA patients.

Conclusion: The pattern and the power $<$ 0.6 Hz of FFT result obtained from the cardiorespiratory signal detected by the PZT sensor may have a potential to be new indices for the separation between central and obstructive sleep apneas.

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0279

SLEEP: AUTOMATIC CLASSIFICATION OF SLEEP STAGES USING FEATURES EXTRACTED PHOTOPLETHYSMOGRAPHY

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Introduction: Sleep stages are manually classified by sleep experts based on electroencephalogram (EEG), electrooculogram (EOG) and electromyogram (EMG) during nocturnal polysomnography (PSG) study as a gold standard method for evaluating the quality of sleep. However, it is expensive, time-consuming, labor intensive, and technically complex. We proposed a method for automatically classifying sleep stages (wake, non-REM sleep, and REM sleep) using time and frequency domains-based features extracted from a photoplethysmography (PPG).

Methods: Nocturnal PSG recordings were obtained during the sleep of 12 subjects (9 men) at Samsung Medical Center (Seoul, Republic of Korea). Sleep expert performed sleep scoring for each subject using the PSG recordings. This study consisted of the following steps: (1) preprocessing of the PPG signal obtained from the nocturnal PSG (e.g. power line noise cancellation, removal of respiratory modulation), (2) pulse-to-pulse interval (PP interval) computation and peak detection algorithm of PPG signal, (3) six features extraction each 30-seconds epoch from PP interval values; mean normal to normal beats (meanNN), standard deviation of NN (SDNN), root mean square of SD (RMSSD), low frequency (LF, 0.04~0.15 Hz), high frequency (HF, 0.15~0.4 Hz), and LF/HF ratio, (4) optimal features selection used each classifier (classification of wake/sleep and classification of non-REM/REM sleep) based on statistical analysis, (5) classification of sleep stages based on support vector machines (SVMs), and (6) evaluation of classification performance using leave-one-out (LOO) cross validation.

Results: The optimal features for each classifier were selected when there is statistically significant differences ($p < 0.05$) between two classes. Consequently, we selected three features (meanNN, SDNN and LF) for classification of wake/sleep and two features (meanNN and RMSSD) for classification of non-REM/REM sleep. Average accuracy rate was 72.6% as compared with the sleep scoring data of nocturnal PSG. Also, classification performances of wake, non-REM and REM class were 85.4%, 82.2%, and 68.7%, respectively.

Conclusion: The PPG-based method is feasible for a system to classify automatically sleep stages in a home environment without any other physiological signals.

Support (If Any): This work was supported by the Technology Innovation Program (10040408, Development of CPAP for sleep apnea) funded by the Ministry of Trade, Industry and Energy (MOTIE, Korea).

0280

A SYSTEM FOR APPLYING SLEEP DEPRIVATION TO A SINGLE ANIMAL IN A GROUP-HOUSED ENVIRONMENT

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Introduction: Sleep deficiency changes the physiology of individually-housed rodents. However, sleep deprivation of a single animal living in a co-housed environment has not been characterized. Sleep deprivation within a group-housed situation is difficult because multiple animals must be tracked and the target animal must remain awake with minimal interference to others. Herein, we describe and test an automated system addressing both of these requirements.

Methods: Two cohorts of four rats were implanted with RFID tags. Each cohort was housed together within a 2' \times 2' \times 1.5' cage with food and water available ad lib. Animal movement within the cage was tracked using high-definition video cameras. Animal occlusion events were resolved through use of an RFID tag on each animal and read via a robotic arm. 24 hours of baseline activity was recorded followed by a six-hour period of sleep deprivation applied just prior to lights off and 24 hours of recovery. Sleep deprivation was achieved using a 0.75" diameter safe, spring-loaded cylinder at the end of the robotic arm. When the target animal was assessed to be asleep ($>$ 40 sec. of inactivity) the arm gently nudged the animal until $>$ 1 minute of movement was recorded.

Results: The effectiveness of sleep deprivation was assessed by comparing the amount of sleep in the six hours following the end of the deprivation period to the equivalent time period of the baseline day for the target animal. In cohort 1, the target animal increased sleep time during recovery by 65% while the target animal in cohort 2 increased by 22%. In both cohorts, the number of sleep bouts increased by \sim 40% while the average bout duration increased in cohort 1 and decreased in cohort 2.

Conclusion: Sleep deprivation of a single animal within a group housed environment is possible using this system.

Support (If Any): This research was supported by NIH grant #1R43MH098595.

0281

THE EEG FINGERPRINT OF REM: ANALYSIS OF BRAIN RECURRENCE (ABR) ACCURATELY IDENTIFIES REM USING A SINGLE EEG LEAD

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Introduction: Conventional electroencephalogram (EEG) analysis requires identification of features within the waveform, described in terms of morphology, frequency, amplitude, and location. Non-rapid eye movement (NREM) sleep stages (N1, N2, and N3) are defined solely by such features. Staging rapid eye movement (REM) sleep, however, requires incorporation of other physiologic parameters (electrooculogram, chin electromyogram), due to visual similarities in EEG patterns found in N1, Wake, and REM. We previously developed an objective computer-based (CB) algorithm for characterizing recurrence of EEG patterns (analysis of brain recurrence (ABR)) and identified sleep depth markers that reliably separated NREM sleep stages, but could not disambiguate REM. The presence of tonic and phasic EEG activity in REM suggested that extended ABR variables capturing patterns of recurrence variability (*fragmentation*) would permit reliable detection of REM.

Methods: The cohort comprised 40 subjects (20 with, and 20 without obstructive sleep apnea (OSA)) who had undergone overnight PSG. EEG signals from a single lead (C3) were digitized and evaluated in a standard numerical computing environment. ABR markers for sleep depth and fragmentation were analyzed to place each 30-second epoch into one of three classes: wake after sleep onset, REM, or NREM. The primary outcome variable was percent REM sleep (%REM), defined as time in REM sleep divided by total sleep time (as determined by the algorithm), compared to %REM as determined by ground truth (expert staging).

Results: The CB-ABR algorithm identified mean %REM sleep in subjects with OSA as $17 \pm 4\%$, statistically matching the results obtained by expert visual analysis staging of the PSG ($17 \pm 3\%$). In subjects without OSA, the CB-ABR algorithm showed similar precision, compared with ground truth ($24 \pm 6\%$ vs. $23 \pm 5\%$, respectively).

Conclusion: A CB-ABR algorithm allowed precise identification of REM sleep, disambiguated from wake and NREM sleep, using only a single EEG lead, in subjects with and without OSA.

0282

WIRELESS PATCH SENSOR FOR SCREENING OF SLEEP APNEA

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Introduction: Sleep Apnea Syndrome (SAS) is highly prevalent worldwide and severely affects quality of life. SAS screening with self-reported symptoms, upper-airway features, physical exam and questionnaires have been reported with reasonable sensitivity but poor specificity. Challenges with polysomnography (PSG) for SAS screening include high operating costs, inadequate availability and limited repeatability. We present a novel SAS screening tool using the Vital Connect HealthPatch™ sensor.

Methods: Volunteers (n = 53) of healthy and SAS patients were recruited for an overnight PSG. HealthPatch™ is an adhesive wireless sensor that

can continuously measure ECG, actigraphy and many derived physiological metrics. Patch sensors were attached to the chest at three specified locations and orientations along with standard PSG. Each sensor was wirelessly connected to a smart phone via Bluetooth Low Energy and data were recorded. Per AASM guidelines, sleep technicians carried out sleep scoring on PSG data. Features were computed based on the overnight time-domain, frequency-domain, and nonlinear analyses of heart rate variability, ECG and accelerometry derived respiratory signals, posture, and movements. Support Vector Machine classifiers were trained on the feature set to detect moderate-to-severe apneic subjects (with apnea-hypopnea index ≥ 15). The classifiers were optimized using sequential backward feature selection with leave-one-out cross-validation.

Results: The performance (specificity, sensitivity) of the SAS screening algorithm was found to be (87.9%, 100%), (100%, 91.7%) and (96.2%, 100%) for the three patch locations, respectively. The accuracies (with 95% confidence intervals) were 91.5% (80.0-96.6%), 97.5% (87.2-99.6%) and 97.1% (85.5-99.5%) for the three patch locations, respectively. The results indicate that all the three chest locations can be used for accurate and effective SAS screening.

Conclusion: Overnight physiological monitoring with an unobtrusive patch sensor is an effective SAS screening tool. Such an inexpensive and disposable patch sensor can be very useful for widespread screening of SAS risk before the use of full PSG tests.

0283

FATIGUE DURING DEADLY FORCE DECISION-MAKING: MEASURING SKIN CONDUCTANCE IN SIMULATIONS

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Introduction: Sleep deprivation impairs risky decision-making. Skin conductance level (SCL) peaks in anticipation of risky decision outcomes and has been used as a measure of affective processes which may guide behavior. SCL may thus be a useful tool for investigating affective and cognitive processes underlying risky decision-making deficits due to sleep loss. We set out to measure SCL in deadly force decision-making (DFDM) in high-fidelity simulators developed for training police officers. However, SCL measurement within the simulators had not been previously attempted. This pilot study evaluated SCL during DFDM within the simulators, using different response devices and levels of interactivity.

Methods: 7 civilians (4 females) completed 16 DFDM scenarios in a high-fidelity simulator. During each of four 15-minute sessions, subjects were connected to skin conductance electrodes and then experienced 4 short scenarios simulating a police officer responding to a situation in which deadly force may or may not become appropriate. Subjects were asked to either actively interact with the characters on screen or passively observe the scenarios. The decision to use force was then indicated either by wielding an inert handgun or a trigger-style wireless computer mouse. Two minutes of rest separated each scenario, and 30 minutes of rest separated each session. Data were analyzed with repeated-measures ANOVA.

Results: Within scenarios, SCL steadily increased from baseline to a peak just before the deadly force decision point. Area under the curve (above the baseline floor) was used to quantify SCL responses. Use of the mouse showed greater SCL than use of the gun ($F_{1,6} = 6.4$, $P < 0.05$). Active viewing showed greater SCL than passive viewing ($F_{1,6} = 9.8$, $P < 0.05$).

Conclusion: In high-fidelity DFDM simulations involving civilian subjects, using a trigger-style wireless mouse rather than an inert gun and

actively interacting with the simulation scenarios produced the most robust SCL responses. These findings inform future studies of simulated DFDM during sleep deprivation to examine affective processes underlying sleep loss-induced deficits in risky decision-making in the real world.
Support (If Any): ONR grant N00014-13-1-0302.

0284

ODDS RATIO PRODUCT QUANTIFICATION OF PLMS AND SLEEP DISTURBANCE IN PATIENTS WITH RESTLESS LEGS SYNDROME

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Introduction: Since the publication of the Rechtschaffen and Kales scoring manual (1968), except for minor revisions to scoring Periodic Limb Movements (PLMs) and arousals, little has changed in the way sleep patterns have been quantified. The newly developed Michelle Scoring System has been validated to show high inter-rater and inter-laboratory reliability for scoring sleep stages and respiratory disturbance. Further, it has been used to demonstrate differences in cardiovascular responses to nighttime arousals with implications on sleep related events in hypertension development. The Michelle system generates an elaborate algorithmic value called Odds Ratio Product (ORP), which is the probability that the power spectrum of EEG pattern analyzed in three-second interval reflects a waking pattern. The ORP index ranges from 0 to 2.5 with higher values reflecting more sleep disruption. In an analysis of baseline polysomnographys (PSG) of fibromyalgia patients we reported that ORP correlated with levels of alpha wave intrusion into sleep. We are reporting analysis of ORP in patients with restless legs syndrome (RLS).

Methods: Seven patients meeting the international RLS Study Group criteria for moderate to severe RLS underwent PSG recordings. Records were scored for sleep architecture, respiratory parameters and PLMs during sleep (PLMS). The relationship between ORP values for total sleep and PLMS was assessed by Spearman rank- order correlation.

Results: The mean all-stages ORP for the RLS patients was 1.14 ± 0.16 . The patients averaged 37.1 ± 13.48 PLMS per hour of sleep. ORP correlated with PLMS with a Pearson correlation coefficient of 0.77 ($p = 0.049$), reflecting levels of sleep disturbance similar to the average ORP value of 1.1 previously reported in patients with moderate Obstructive Sleep Apnea (OSA).

Conclusion: These results extend previous findings that ORP may be a useful tool in quantifying sleep disturbance. Further, they suggest that PLMS may cause levels of sleep disruption similar to OSA.

Support (If Any): The study was supported by Xenoport.

0285

TWO'S COMPANY: CAPTURING PARTNER IMPACT DURING SLEEP

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Introduction: The majority of sleep research is conducted with the view that sleep is a solitary activity, despite the fact that many share a bed or home during sleep. Few analyses have attempted to capture sleep disruption associated with a partner, an issue in dyads where one partner experiences sleep disturbance. This study aimed to quantify objective partner disruption in older adult dyads.

Methods: Eleven community-dwelling older adult couples ($N = 22$, aged 66-85 years) completed 14 nights of monitoring via an Actiwatch-2 and sleep diary. Epochs within rest intervals (set via sleep diary), were scored as sleep or wake using medium sensitivity in Actiware software (version 5.71). The shared sleep period was examined for transitions

from epochs scored as sleep to epochs scored as wake. To quantify the degree of sleep disruption associated with the partner, partner sleep-wake state in each epoch immediately prior to sleep-wake transitions was recorded.

Results: On average, transitions from sleep to wake epochs were preceded by wake in the partner 14.09% of the time ($SD = 7.10\%$), with a range of 5-29% and significant night-to-night variability within participants. The proportion of the shared sleep period spent in wake epochs (sleep efficiency) and the proportion of wake prior to a partner's transition were significantly correlated ($r = .86$, $p < .001$). Altering sleep/wake scoring sensitivity impacted the proportion of transitions preceded by partner wake.

Conclusion: These data suggest that a significant number of sleep/wake transitions are associated with prior wake in the dyad partner, and that those with poor sleep quality may disrupt their partner more often. Whilst not accounting for disruption from external stimuli or snoring, simultaneous actigraphic monitoring provides one method of capturing partner disruption and consequences of co-sleeping in those with poor sleep quality.

Support (If Any): Wesley Research Institute.

0286

SCORING SLEEP LATENCY USING CONSECUTIVE SECONDS OF SLEEP IN THE MULTIPLE SLEEP LATENCY TEST (MSLT)

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Introduction: The conventional epoch-based approach to scoring sleep latency may artificially prolong sleep latency and cause increased distribution of the mean sleep latency. Defining sleep onset using consecutive seconds of sleep may narrow the distribution of mean sleep latency and potentially increase the sensitivity and specificity of the MSLT. The purpose of our study was to evaluate whether scoring mean sleep latency with a consecutive seconds of sleep approach would significantly change sleep latency compared to standard epoch-based scoring.

Methods: Retrospective study evaluating MSLTs conducted between 2010 and 2013 in the sleep disorder center at our military medical center. Original scoring was removed and sleep latency was determined using both the conventional epoch-based approach and the consecutive seconds of sleep method at thresholds of 5, 10, 15, 20 and 25 seconds. Mean sleep latencies, as well as standard deviations of sleep latencies, were compared using a regression model for statistical significance.

Results: The database contained 50 patients. At the time of abstract submission, a pilot sample of 5 patients had been analyzed. The mean sleep latency of the epoch based approach was 716.4 ± 383.5 seconds. The mean sleep latency of the consecutive seconds based approach was: 593.3 ± 428.02 seconds ("5 seconds threshold"), 669.6 ± 405.07 seconds ("10 seconds"), 712.5 ± 387.71 seconds ("15 seconds"), 753.5 ± 379.52 seconds ("20 seconds"), and 797.32 ± 357.9 seconds ("25 seconds"). Mean sleep latency was not significantly different between any of the consecutive seconds of sleep thresholds and standard epoch-based scoring.

Conclusion: The consecutive seconds based scoring approach did not significantly alter mean sleep latency scores compared to standard epoch-based scoring. Further studies evaluating this technique are needed to determine if specific patient populations might derive clinical benefits from changes in sleep latency scoring technique.

0287

DEVELOPMENT OF A USER-FRIENDLY PLATFORM FOR REAL-TIME AUTOMATED SCORING OF POLYSOMNOGRAPHY DATA*Allocca G^{1,2}, Martelli D¹, Hosken I^{1,2}, Freestone D³, Johnston L^{1,3}, Gundlach A^{1,2}*

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Introduction: The low-throughput nature of manual scoring of sleep data is a major factor preventing sleep research from reaching its full efficiency and potential. Automated approaches developed previously have generally failed to provide sufficient accuracy or 'usability' for sleep scientists without engineering expertise. Therefore, the aim of our research is to develop a user-friendly platform for real-time automated scoring of polysomnography data, known as GCSP.

Methods: We have employed a support vector machine (SVM) to classify EEG/EMG features into the various sleep stages. The SVM is adaptive and is tailored to individual subjects by the user updating erroneous decisions to create and refine individual training data. In this way, the software learns from the user how to score polysomnography data automatically using the empirical analysis process of human scorers. The SVM is trained for each individual set of data to offset inter-subject variability in EEG/EMG traces, via a brief session of manual scoring. After teaching the overall characteristics of different sleep stages in terms of EEG/EMG features, the user has control over sequential scoring decisions and can enforce subjective decisions using the same intuitive rules employed during manual scoring, which applies a further decisional level over the purely mathematical decisions of the SVM kernel.

Results: After manual training, GCSP produced automated scoring coherence with three in-house sleep experts of 94-96% across all sleep/wake states, and reduced scoring times from hours to just seconds. GCSP is also capable of scoring real-time during EEG/EMG recording.

Conclusion: Our approach aims to link a sophisticated automated computational system to the empirical decisions of sleep scientists. We are also developing a biofeedback-driven sleep deprivation apparatus, which should eliminate current limitations of variable stress levels, slow throughput and poor reproducibility in sleep deprivation studies. Once fully developed, GCSP will provide accurate, reliable high-throughput scoring of polysomnography data in a range of experimental situations.

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0288

WEIGHTED STOP-BANG AND SCREENING FOR SLEEP DISORDERED BREATHING

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Introduction: The STOP-Bang scoring tool is a clinical-prediction tool that was developed in order to predict the likelihood for sleep-disordered breathing (SDB) in pre-operative patients. The STOP-Bang tool uses four subjective items (snoring, tiredness, witness apnea, and history of hypertension) and 4 objective items (body mass index [BMI] > 35, age > 50 yrs, neck > 40 cm, and male gender) in its calculation. All 8 dichotomous items contribute equally to the total score, and there is no preference given to those items that may be considered to confer a higher risk for SDB.

Methods: Data from subjects who participated in the Sleep Heart Health Study (SHHS) were included in this analysis using an initial derivation dataset (n = 543) and a validation dataset (n = 4597). SDB was defined as apnea-hypopnea index > 15 per hour with 4% oxygen desaturation threshold. In the initial derivation dataset (n = 543), we regressed the individual STOP-Bang variables against the presence or absence of SDB in order to determine the coefficients that would allow us to weight the variables. However, BMI, age, and neck circumference were treated as continuous variables. The sum of the weighted variables yielded a weighted STOP-Bang score (wSTOP-Bang). The wSTOP-Bang score and the conventional STOP-Bang score were then both applied to the validation dataset (n = 4597) and receiver operating characteristic (ROC) curves were constructed. The Area under the curve (AUC) of the ROCs were compared.

Results: The AUC of ROC for wSTOP-Bang (0.745; Standard error [SE] 0.009; 95% Confidence Interval [CI] 0.727, 0.762) was greater than that of the conventional STOP-Bang (0.713; SE 0.01; 95% CI 0.693, 0.732) P-value = 0.035.

Conclusion: The wSTOP-Bang scoring tool had a statistically significant higher AUC than conventional STOP-Bang. Whether the wSTOP-Bang is a better predictor of SDB will await studies in clinical populations.

0289

RISK FACTORS FOR OSA BASED ON RESULTS FROM 200,421 PATIENTS UNDERGOING PORTABLE RECORDING: GENDER DIFFERENCES AND IMPLICATIONS FOR SCREENING

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Introduction: Risk factors used for predicting obstructive sleep apnea (OSA) based on laboratory PSG outcomes are well-known/quantified and include increased adiposity and age, male sex, hypertension, diabetes, and stroke. However, it is less well-understood how some of these risk factors used to predict OSA align with outcomes from at-home diagnostic testing using portable recording (PR). We present here AHI outcome data across well-known risk factors for OSA from the largest-to-date clinical sample of patients being tested for OSA via a PR system used in the home.

Methods: The Apnea Risk Evaluation System (ARES) includes a forehead-worn PR device that simultaneously records airflow, oxygen saturation, pulse rate, snoring, and head position/movement. The system

integrates a pre-test screening questionnaire which assesses self-reported symptoms of OSA, anthropomorphic indices, and common comorbid medical conditions. Data were obtained from 118,248 men and 82,173 women (ages 18-90 yr) from across North America tested between January 2009 and October 2013. The presence of OSA was defined as an apnea hypopnea index (AHI) of ≥ 5 . Risk analyses were computed using odds ratios (OR) and gender interactions were evaluated using multivariate ANOVA and moderation regression.

Results: Risk factors for the diagnosis of OSA based on PR included hypertension (OR: 2.3; CI: 2.25-2.35), heart disease (OR: 2.2; CI: 2.07-2.23), male sex (OR 1.9; CI: 1.91-1.99), diabetes (OR: 1.9; CI: 1.84-1.96), and a history of stroke (OR: 1.6; CI: 1.54-1.75). Body mass index and neck circumference were better predictors of OSA for males than for females; $F(3, 200,008) = 656.5$, $p < .001$ and $\Delta R^2 = .004$, $\Delta F(1, 200417) = 960.9$, $p < .001$, respectively whereas age was a stronger predictor in females; $\Delta R^2 = .001$, $\Delta F(1, 200417) = 146.1$, $p < .001$.

Conclusion: Risk factors for OSA based on home PR data are similar to those based on laboratory PSG. The finding that anthropomorphic indices were more robust predictors of OSA in males may be related to differences in fat distribution (i.e. central vs. peripheral). Further analyses will explore how age relates to OSA risk in females. Future studies should investigate gender-appropriate OSA screening measures.

0290

HOME SLEEP TESTING

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Introduction: Home sleep testing (HST) is being increasingly utilized for identification of obstructive sleep apnea (OSA). Current clinical guidelines recommend review of the HST record by a sleep specialist. Frequently, to expedite the diagnostic assessment, automated algorithms are used for analysis of the HST data without review by the treating healthcare provider or a sleep specialist. The purpose of the current study was to assess the utility of the sleep specialist by assessing the level of agreement between results derived from HST data with and without review by a specialist.

Methods: Two distinct study samples underwent HST with two different type 3 devices. The first sample was an "at risk" cohort screened with an Embletta® device. The second sample consisted of community-based people screened with the Apnealink Plus® device. For both samples, HST records were subjected to automated scoring as per manufacturer's recommendations and manual scoring by a sleep trained physician. Varying thresholds of oxyhemoglobin desaturation and airflow were used to score hypopneas. Agreement between automated versus expert review-derived ODI and AHI was assessed using the Pearson's correlation coefficient and Bland-Altman plots.

Results: A total of 185 portable monitoring records were reviewed (Embletta = 90 and Apnealink = 95). The Pearson correlation coefficients for the sample using the Embletta device were as follows: ODI3% 0.99, ODI4% = 0.99, AHI3% = 0.54, AHI4% = 0.73. The correlation coefficients with the sample using the Apnealink Plus device were as follows: ODI3% = 0.99, ODI4% = 0.995, AHI3% = 0.97, AHI4% = 0.98. Bland-Altman plots consistently demonstrated underestimation with automated scoring versus sleep specialist review when AHI was used as the OSA-defining metric. Estimated bias ranged from 4.77 -9.06 events/hr.

Conclusion: Comparing HST data with and without a specialist review, a strong correlation between automated and manual scoring was notable for the ODI and AHI. However, significant variability and systematic underestimation of disease severity was noted with the AHI derived from HST without a specialist's review. HST can be performed without

review by a sleep specialist. However, as with any diagnostic test, additional testing and expert input may be needed in those patients where the HST is non-concordant with OSA-related clinical symptoms or risk. **Support (If Any):** NIH Grant HL075078.

0291

INTER-SCORER AGREEMENT ACROSS MULTIPLE SITES FOR IDENTIFYING INSPIRATORY FLOW LIMITATION IN SLEEP STUDIES WITH LOW APNEA-HYPOPNEA INDEX

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Introduction: Reliable assessment of inspiratory flow limitation (IFL), characterized by flattening on a nasal pressure transducer tracing and likely reflecting increased upper airway resistance, could enhance evaluation of sleep-disordered breathing, particularly among symptomatic patients with a low apnea-hypopnea index (AHI). However, the assessment of IFL is not standardized and despite the variety of manual and automated methods reported, few have been rigorously validated. We report here on the current agreement seen across multi-center manual scoring, with the long-term goal of developing a standardized, consensus-based approach for visual scoring of IFL in sleep studies.

Methods: Consensus scoring rules for IFL were developed at each of 4 laboratories (McGill, Harvard, NYU, Instituto Do Sono). A total of 1000 epochs, sampled from 5 sleep studies on pregnant women with low AHI and varying degrees of IFL, were independently evaluated. Using software to tag each breath manually, 8 scorers rated IFL as follows: normal (N), intermediate (I) and definitely flow limited (FL). Breath-by-breath agreement was tabulated.

Results: Of 5283 scored breaths, 1139 (21.6%) had > 80% agreement and were comprised of 52% FL-breaths, 16% I-breaths and 32% N-breaths. The overall agreement across all breaths revealed an intra-class correlation coefficient of 0.46 (95% CI 0.41, 0.51). The agreement across breath categories was fair for FL-breaths ($\kappa = 0.36$), poor for I-breaths ($\kappa = 0.12$) and fair for N-breaths ($\kappa = 0.37$).

Conclusion: In this initial assessment, trained scorers from different sleep centers working with local definitions of IFL varied substantially in their scoring, indicating that IFL is likely inconsistently identified in clinical and research settings. Further work is required to establish a standardized, consensus-based approach that can then be applied to validate automated algorithms and evaluate relationships between IFL and clinical outcomes where AHI is low, such as in pregnancy and pediatric sleep apnea.

0292

CHANGES OF ELECTROENCEPHALOGRAPH WITH FLOW LIMITATION DURING NREM STAGE II SLEEP IN PATIENTS WITH UPPER AIRWAY RESISTANCE SYNDROME EVALUATED BY A NOVEL RESPIRATORY CYCLE-BASED ANALYSIS

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Introduction: Flow limitation with respiratory effort in patients with upper airway resistance syndrome (UARS) can induce parasympathetic hyper-activation but the biological consequences on sleep EEG are un-

clear. Therefore, a physiologically defined cycle-based analysis was applied to explore the changes of EEG during flow limitation.

Methods: The PSG of subjects with well-defined clinical complaints and suspicion of sleep-disordered breathing based on clinical symptoms and clinical evaluation were collected. Hilbert-Huang transform was applied to C4-M2 data and time-frequency representation of EEG was reconstructed. The instantaneous power of different frequency bands—lower delta (0.3~1.5 Hz), high delta (1.5~4 Hz), theta (4~8 Hz), alpha (8~12 Hz), sigma (12~15 Hz), and beta (15~35 Hz) were extracted; then, the standard deviation and average of power within each respiratory cycle was calculated. The respiratory cycles of each patient were divided into 4 groups according to two criteria: respiratory efforts greater/less than -5 cm H₂O (measured with esophageal manometry) and normalized flow pressure (nasal cannula-pressure transducer wave contour) greater/less than 40% and labeled as normal cycles (effort < -5 cm H₂O and flow > 0.4), increased respiratory efforts cycles with minimal flow limitation (effort > -5 cm H₂O and flow > 0.4), flow limitation cycles without respiratory effort [effort < -5 cm H₂O and flow < -5 cm H₂O and flow < 0.4; FL(+)]. The derived parameters of the cycles in each group were averaged for each patient.

Results: Forty-nine UARS patients (mean age, 26.8 ± 5.8 years; BMI, 22.2 ± 2.9 kg/m²; 12 males and 37 females) were included in this study. The AHI of those patients was 3.1 ± 1.5 per hour. Only the mean power of sigma band was significantly higher in FL(+) group compared to that of normal cycle group. The mean power of other frequency bands was not different among all groups. However, the standard deviation of the power in low delta band was significantly higher in the minimal flow limitation with respiratory effort group and FL(+) compared to normal group and FL(-). ($p < 0.05$)

Conclusion: Rather than only taking the mean power into account, the time-related changes of EEG is a more important feature during high respiratory efforts. The proposed method gives better time-frequency representation of signal to quantify alterations in EEG and the mechanisms such as subtle cortical microarousals and/or activation of central nervous system underlying patients' complaint. This technique warrants further studies on larger group of patients, particularly those with UARS.

0293

RESPIRATORY CHEMOREFLEX ACTIVATION AND ATRIAL FIBRILLATION

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Introduction: Sleep apnea seems to increase the risk for atrial fibrillation (AF) yet the vast majority of even the most severely affected patients do not develop AF. The polysomnographic hallmark of a strongly activated respiratory chemoreflex in non-rapid eye movement sleep dominant apnea (NREM-D apnea); this term captures central sleep apnea (CSA), periodic breathing, and complex sleep apnea by any definition. Idiopathic central sleep apnea is strongly associated with AF, and coexistence of CSA and AF has been reported.

Methods: 1) Using billing records from 2005 to 2012, the prevalence of atrial fibrillation in obstructive sleep apnea vs. obstructive sleep apnea + periodic breathing / central sleep apnea (there is currently no ICD code for "complex apnea") was estimated; 2) 215 consecutive subjects evaluated in the clinical sleep laboratory who have or had atrial fibrillation from 7/2011 to current had polysomnogram review. Periodic breathing was tagged regardless of the presence of flow-limitation and cycle lengths.

Results: 1) Of 2805 unique patients, 1640 (58.5%) were men; 692 (24.6%) were coded for "complex apnea". The mean age was 58.7 ± 16 years. Thirty-nine patients were also coded for atrial fibrillation (by any physician at the medical center, not just the sleep center). Using logistic

regression and adjusting for age, gender, and medical comorbidities, the odds of atrial fibrillation was 11.4 [CI: 5.2-25.3, $p < 0.001$] in those coded as complex vs. obstructive sleep apnea. 2) 90% of patient with current or past AF (66% and 34% respectively) had NREM-D apnea. A minority ($< 5\%$) of patients had a central AHI ≥ 5 /hour of sleep.

Conclusion: A strongly activated respiratory chemoreflex is very common in patients with AF regardless of current rhythm. This relationship may not be readily captured by current scoring criteria.

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0294

IMPROVEMENT IN ACTIGRAPHY-DERIVED SLEEP METRICS FOLLOWING PAP-THERAPY IN OSA

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Introduction: Emerging evidence indicates that self-reported sleepiness recovers gradually over months in response to continuous positive airway pressure (PAP) in obstructive sleep apnea (OSA). The rate of improvement depends on both PAP-adherence and OSA severity. This study aimed to test whether actigraphy-based objective sleep metrics showed a parallel pattern of gradual improvement for OSAs. To that end we tested: a) whether OSAs differed from controls on objective sleep-metrics pre-PAP; b) whether OSAs showed larger changes from pre-PAP to post-PAP compared to controls consistent with improvement; c) whether objective sleep metrics were correlated with PAP-adherence, disease severity, and subjective ratings of improvements.

Methods: Participants included 73 OSAs and 33 healthy controls (matched at group level to age within 5 years and education within 2 years). Daily PAP-adherence and actigraphy-based sleep metrics were summarized at the week-level from pre-pap to 3-months post-PAP. Monthly ratings of Epworth Sleepiness Scale and Functional Outcomes of Sleep Questionnaire data were available from pre-pap to 3-months post-PAP.

Results: OSAs had lower sleep efficiency and higher wake minutes after sleep onset than controls pre-PAP ($p < .05$) but did not differ on awakenings or total sleep time. OSAs improved on number awakenings from pre-PAP to post-PAP ($p < .05$). PAP-adherence was moderately correlated with sleep efficiency, number of awakenings, and total sleep time (p 's $< .05$). SpO₂ Nadir predicted improvements in number of awakenings. Objective sleep metrics were not correlated with subjective indices of functioning.

Conclusion: 30-40% of OSA patients have residual impairments on self-reported sleepiness and even larger proportions appear impaired based on objective measures even after 3-months of PAP-therapy. Current findings are consistent with earlier reports in that improvement in actigraphy-based sleep metrics lag behind those in self-reports. The results help inform clinical management, timing of follow-up, and expectations for recovery in OSA following PAP-therapy.

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0295

OPTIMAL TIDAL VOLUME FOR AVERAGE VOLUME ASSURED PRESSURE SUPPORT (AVAPS) IN OBESITY HYPOVENTILATION SYNDROME

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Introduction: AVAPS is a mode of pressure-support and volume-controlled ventilation that delivers a more consistent tidal volume (V_T)

initially chosen by calculations using the patient's ideal body weight (IBW): 8-10 mL/kg. AVAPS was developed for the management of progressive neuromuscular disease. The optimal V_T for patients with obesity-hypoventilation syndrome (OHS) has not been determined. We have observed that prescribing these traditional tidal volumes may be sub-optimal for the treatment of hypoventilation in patients with obesity-hypoventilation syndrome (OHS) as seen by persistently high pCO₂ levels with AVAPS set at these volumes. We hypothesize that patients with OHS require a higher V_T /IBW for effective treatment of hypoventilation with AVAPS, compared to the commonly recommended V_T .

Methods: We performed a retrospective chart review of all adult patients referred to our sleep laboratory with the diagnosis of OHS who underwent AVAPS titration between July 2010 and November 2013. Demographic, baseline and titration polysomnography (PSG) data with capnometry were collected. End-tidal CO₂ was used during baseline PSGs and transcutaneous CO₂ during titration PSGs. We assessed the initial set V_T and compared it to the effective V_T required to maintain the pCO₂ below 50 torr during sleep.

Results: We evaluated 10 patients with OHS undergoing AVAPS titration. Eight of these subjects were female. The mean age was 55.5 ± 30.8 (SD) years with a mean BMI of 49.5 ± 9.4 kg/m². The mean baseline (supine awake) pCO₂ was 51.4 ± 4.8 torr, with an obstructive apnea hypopnea index (AHI) of 52.2 ± 41.9 and average percent sleep time with pCO₂ above 50 torr was $73.4 \pm 19.3\%$. The V_T initially ordered for the titration averaged 9.6 ± 2.4 mL/kg IBW and the effective V_T was 11.5 ± 2.9 mL/kg IBW (range 8.2-16.1 mL/kg IBW). With AVAPS, the mean AHI fell to 5.2 ± 4.3 ($p = 0.003$) with a fall in percent time with pCO₂ above 50 torr to $38.73 \pm 29.6\%$ ($p = 0.009$).

Conclusion: Effective V_T for resolution of hypoventilation in OHS may be higher than required for other causes of hypoventilation, and 8-10 mL/kg IBW may be inadequate for many OHS patients. Future studies with a larger patient population may be of benefit to assess more uniform response rates in treating OHS.

0296

AN EDUCATIONAL SMART PHONE APPLICATION IMPROVES CPAP ADHERENCE

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Introduction: Patient education is associated with increased adherence to CPAP but it is labor intensive. The Sleep Mapper (Philips Respironics) is a smart phone application with blue tooth connectivity that allows patients to access their compliance and efficacy data and provides educational modules to help them understand their disease and its treatment. We studied the effect that Sleep Mapper has on CPAP adherence rates.

Methods: Patients initiating CPAP for OSA were randomly designated to receive the Sleep Mapper application versus usual care. Linear regression (SPSS 20.0) was used to isolate the effect that Sleep Mapper use had on outcomes.

Results: A total of 61 (30 Sleep Mapper and 31 standard of care) patients were analyzed for outcomes. The mean age and median AHI on PSG were 44.5 ± 11.3 versus 41.1 ± 6.8 ($p = 0.31$) and 19.3 ($10.1-25.3$) versus 18.1 ($10.3-29.5$) ($p = 0.86$) for Sleep-Mapper and control patients respectively. Sleep Mapper patients showed a trend toward having an increased sleep efficiency (85.0 ± 9.9 versus 78.4 ± 15.4 ; $p = 0.05$) on baseline PSG. Univariate analysis showed sleep mapper patients used their machine for a higher percentage of nights ($78 \pm 22\%$ versus $56 \pm 24\%$; $p < 0.001$) and achieved 4 hours of use for a higher percentage of nights ($54 \pm 27\%$ versus $37 \pm 25\%$). Using linear regression to control for the effects of sleep efficiency and initial pressure settings (both were also associated with adherence at 11 weeks) we found patients in the sleep mapper group were still significantly more likely to use their

machine for 4 hours per night ($p = 0.04$). The number of times the Sleep Mapper patients accessed their application was significantly associated with percentage of nights of CPAP use > 4 hours ($r = 0.46$; $p < 0.001$).

Conclusion: The Sleep Mapper application was independently associated with improvements in adherence to CPAP. Higher rates of application use were correlated with increased adherence.

0297

COMORBID OSA AND PTSD: EFFECT ON OUTCOMES AND IMPACT OF CPAP

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Introduction: OSA is common among patients with PTSD and portends worse outcomes. We determined the prevalence of OSA and investigated its impact on quality of life (QOL) and response to therapy.

Methods: Case controlled observational cohort. 200 consecutive patients with combat-related PTSD underwent comprehensive sleep evaluations. We compared polysomnographic data, subjective sleepiness, and sleep-related QOL between PTSD patients with and without OSA to 50 non-PTSD patients with OSA and 50 normal, age-matched controls. For OSA patients, variables were re-measured after 4 weeks of CPAP.

Results: 96.9% of PTSD patients reported sleep complaints. OSA was diagnosed in 56.6%. Patients with PTSD+OSA reported more somnolence, worse mood, and lower sleep-related QOL than either condition alone. 63.2% with PTSD+OSA had an ESS > 10 , compared with 39.2% in PTSD-only patients ($p = 0.005$). Similarly, 53.3% of PTSD+OSA patients had an FOSQ < 17.9 , compared with 27.0% of PTSD-only, 18% of OSA-only, and 4% of normal controls ($p = 0.02$). Compared with non-PTSD patients, PTSD+OSA patients used CPAP on fewer nights ($53.3 \pm 35.6\%$ vs. $77.9 \pm 22.0\%$, $p < 0.001$), for less hours/night (2.6 ± 2.6 vs. 5.8 ± 0.9 , $p < 0.001$), and had less regular use (30.2% vs. 55.1%, $p = 0.02$). CPAP improved symptoms, but the treatment response was less robust in PTSD+OSA patients. Resolution of sleepiness (ESS < 10) occurred in 82% of OSA patients without PTSD, compared with 62.5% of CPAP adherent and 21.4% of non-adherent PTSD patients ($p = 0.008$). Improved QOL following CPAP was also less common in those with PTSD. Post-treatment FOSQ > 17.9 was achieved in 72% of CPAP users without PTSD, compared with 56.3% of CPAP adherent and 26.2% of non-adherent PTSD patients ($p = 0.01$).

Conclusion: OSA is common, and associated with greater symptoms and lower QOL, in patients with PTSD. Patients with PTSD demonstrated poor adherence and a diminished therapeutic response to CPAP. PTSD should be considered a potential barrier to effective therapy, requiring more comprehensive treatment and closer follow-up.

0298

OBSTRUCTIVE SLEEP APNEA: LONG-TERM TREATMENT WITH CONTINUOUS POSITIVE AIRWAY PRESSURE INCREASES MORE EXTENSIVE BRAIN CORTICAL VOLUME

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Introduction: Previous studies have shown that hypopneic events during sleep in patients with obstructive sleep apnea (OSA) cause brain structural alterations. Such structural damages may be recovered by treatment with continuous positive airway (CPAP) that decreases the level of apnea-hypopnea. Only focal cortical volume increases have

been found as a result of short-term CPAP (< 6 months). We therefore assessed effects of long-term treatment to brain structure using longitudinally designed deformation-based morphometry.

Methods: Twenty-one patients with OSA (age: 48 ± 7 years) underwent MRI scans at baseline (apnea-hypopnea index > 25) and after CPAP treatment (duration: 1.6 ± 1 years, median: 1 year). We normalized the brain size by registering MRIs to Talairach space. Follow-up scans were then nonlinearly warped to their baseline scans. From the resulting deformation fields, we computed voxel-wise Jacobian determinants explaining local volume alterations. We then assessed cortical volume increases after treatment using voxel-wise t-tests. To assess effects of long-term treatment, we also compared patients with longer-term CPAP (≥ 1 year, $n = 10$) to the others ($n = 11$).

Results: We found no volume decrease after treatment ($p > 0.2$ after FDR correction). We identified volume increase after treatment, bilaterally in superior frontal, medial pre-frontal, central and insular cortices, and unilaterally in the left hippocampus and right inferior parietal and right posterior temporal cortices ($p < 0.05$). Among these areas, medial prefrontal, superior frontal and posterior temporal cortices presented more volume increase in patients with longer treatment ($p < 0.05$). These patients presented additional volume increase in the neighbouring cortices to those showing recovery after treatment, including bilateral cingulate, middle frontal cortices and unilateral right hippocampus and left parahippocampal gyrus.

Conclusion: Longer CPAP treatment is advantageous producing more extensive cortical volume increase. The areas of recovery after treatment overlaps well with those presenting GM loss in patients with OSA that were observed in previous neuroimaging studies, suggesting that brain damage due to nocturnal hypoxemia can be recuperated with consistent treatment.

0299

CLAUSTROPHOBIC TENDENCIES AND CPAP ADHERENCE IN ADULTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Claustrophobia is commonly identified as influential on CPAP adherence, yet a paucity of evidence exists that delineates this relationship. Study objectives were: (1) determine frequency of claustrophobic tendencies in adults with OSA after first CPAP night; (2) determine if differences in claustrophobic tendencies exist between CPAP adherers and nonadherers; (3) determine if claustrophobic tendencies influence 1 wk and 1 mo CPAP adherence.

Methods: Secondary analysis from a prospective, longitudinal study of newly-diagnosed adults with OSA ($n = 97$). Subject characteristics and Adapted Fear and Avoidance Scale (FAAS) were collected immediately after in-laboratory CPAP titration polysomnogram. Objective CPAP use at 1 wk and 1 mo was dichotomized, < 4 hrs and ≥ 4 hrs/night, and categorized, < 2 hrs, 2-5 hrs, and > 5 hrs/night. Descriptive analysis, Wilcoxon rank sum tests, Chi-square tests, and logistic regression were conducted.

Results: Male (53%) and female (47%), white (90%) adults with severe OSA (AHI 36.7 ± 18.6) had complete data ($n = 68$). 1 mo CPAP use was 4.3 ± 2.5 hrs/night, with 37% using CPAP < 4 hrs/night. Median FAAS score was 27.0 (IQR 23.5-35.5) with 63% demonstrating claustrophobia tendencies (FAAS ≥ 25). Median FAAS was not different among adherers (≥ 4 hrs/night) and nonadherers (< 4 hrs/night) at 1 wk ($p = 0.28$) and 1 mo ($p = 0.48$). FAAS ≥ 25 approached significance as a predictor of 4 hr-adherence at 1 wk ($p = 0.07$), but not at 1 mo ($p = 0.25$), with odds

of 1 wk 4 hr-nonadherence 2.9 times more likely for those with FAAS ≥ 25 compared to FAAS < 25 (95%CI 0.9-9.1; $p = 0.07$). FAAS ≥ 25 was significant predictor of CPAP adherence, categorized as < 2 , 2-5, ≥ 5 hrs/night, at 1 wk (OR = 3.1; 95% CI 1.1-8.2; $p = 0.03$) and at 1 mo (OR 3.2; 95%CI 1.8-8.7; $p = 0.02$). Median FAAS was higher for females than males (33.5 vs. 24.0, respectively, $p < 0.001$); FAAS ≥ 25 was observed in more females (84%) than males (44%; $p < 0.001$).

Conclusion: Claustrophobia is prevalent among CPAP-treated OSA adults and influences adherence, particularly among low hourly users and during early use. Interventions are needed to address this barrier to CPAP adherence.

Support (If Any): Support for this study was provided by NIH/NINR (K99NR011173, AM Sawyer, PI).

0300

TREATING AEROPHAGIA INDUCED GASTRIC DISTRESS (AIGD) ASSOCIATED WITH CPAP THERAPY TO IMPROVE CPAP TREATMENT OUTCOME: UNDERSTANDING THE RELATIONSHIP BEHIND ORAL PRESSURE LEAKAGE AND AIGD DEVELOPMENT IS KEY TO TREATMENT SUCCESS

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Introduction: Aerophagia (swallowing of air) is a common complication of PAP therapy that, when not addressed adequately, can lead to gastric discomfort, typically from distention and increased occurrence of GERD, thus hindering PAP compliance and outcome. The mechanisms leading to aerophagia induced gastric distress (AIGD) have not been well characterized. We studied interventions that resolved aerophagia, allowing us to hypothesize that aerophagia is mainly a result of oral pressure leakage, since resolving the oral leakage also resolved AIGD symptoms. We sought to perform a study to support this hypothesis.

Methods: We included 20 consecutive patients presenting with difficulties acclimating to CPAP associated with AIGD symptoms (e.g. gastric bloating, gastric gas) in the study. Signs and symptoms of oral pressure leakage were sought from the history (e.g., dry mouth, witnessed oral leak). Treatment was directed to resolve oral leakage by either adding a chinstrap or modifying PAP therapy by lowering expiratory pressures via Expiratory Pressure Relief (EPR) or BiLevel PAP therapy. In some cases both a chinstrap and lowering expiratory pressures were implemented. During follow up visits, patients were assessed for symptomatic improvement.

Results: Of the 20 patients (12 male, 8 female, average age 44 y/o), 18 needed a chinstrap on the PAP-titration study. Of those, 3 were chinstrap compliant at the time of AIGD presentation. Chinstrap therapy was administered as a first line intervention. Of the 15 chinstrap non-compliant patients, 7 improved with this addition alone, and 1 patient not recommended a chinstrap initially had AIGD improvement once a chinstrap was applied. Of the 12 remaining patients, 3 improved with the use of expiratory pressure relief (EPR) and the remaining 9 improved by switching to bi-level therapy with low EPAP levels. All overcame AIGD with these interventions.

Conclusion: There limited literature describing the mechanism of aerophagia or AIGD in PAP therapy. Since we identified that methods resolving oral pressure leakage additionally resolved AIGD, we conclude the following: Oral leakage leads to air trapping (filling the mouth with air) at leakage termination, followed by a swallow to remove the oral air. Recurrence of this throughout the night leads to AIGD symptoms. Frequently, addition of a chinstrap was sufficient, but when not, lowering expiratory pressures (by EPR or bi-level PAP) resolved both oral leak and aerophagia. Flow resistance on expiration seems to be a frequent cause of oral leakage with PAP therapy and can lead to AIGD.

0301

THE EFFECTS OF A-FLEX ON AUTO-PAP ADHERENCE AND EFFICACY

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Introduction: Recent data showed the addition of A-flex to auto-titrating continuous positive airway pressure (APAP) does not improve compliance over APAP alone. However a subset of patients with poor APAP compliance show improvements when A-flex is added. We sought to identify baseline patient and PSG variables that predict superior compliance with APAP with A-flex versus APAP alone.

Methods: Patients initiating PAP for OSA were randomly designated to receive either APAP with A-flex or APAP alone. Compliance and efficacy were compared between groups and predictors of compliance were identified.

Results: A total of 106 patients (52 APAP/A-flex and 54 APAP) were analyzed for outcomes. The mean age and AHI on PSG were 46.4 ± 10.3 versus 44.0 ± 9.3 ($p = 0.23$) and 15.3 ± 8.3 versus 14.9 ± 8.9 ($p = 0.78$) for APAP/A-flex and APAP patients respectively. There was no significant difference in maximum (max) / minimum (min) pressure settings, $13.8 \pm 3.5/8.3 \pm 2.0$ versus $13.0 \pm 3.7/8.0 \pm 1.7$ for APAP/A-flex and APAP respectively. There was no difference between groups for percentage of nights used (88.0 ± 18.8 versus 85.3 ± 19.1 ; $p = 0.54$) or percentage of nights greater than 4 hours (75.8 ± 24.7 versus 72.0 ± 23.6 ; $p = 0.50$). Older age ($p = 0.02$), higher AHI ($p = 0.05$) and lower max pressure setting ($p = 0.001$) were associated with compliance of > 4 hours per night for $> 70\%$ (regular use) of nights for the APAP/A-flex group while only lower max pressure settings ($p = 0.05$) were associated with regular use in the APAP group.

Conclusion: Overall the addition of A-flex to APAP did not affect compliance. Patients who were older and had a higher AHI tended to do particularly well with the A-flex setting.

0302

EIGHTEEN-MONTH SAFETY AND EFFICACY OF UPPER AIRWAY STIMULATION IN THE TREATMENT OF OBSTRUCTIVE APNEA

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Introduction: Upper airway stimulation has an established safety and efficacy profile 12 months after implantation for treatment of moderate to severe obstructive sleep apnea in patients who struggle with or refuse continuous positive airway pressure. The aim was to examine if the safety and efficacy of treatment effects persisted to 18 months of therapy.

Methods: All qualified participants underwent a screening polysomnographic (PSG) study, surgical consultation and drug-induced sleep endoscopy (DISE). Participants without complete concentric collapse at the retropalatal airway received an implanted neurostimulator (Upper Airway Stimulation system, Inspire Medical Systems, Minnesota). All implanted participants are reported for 18 months follow-up to provide overall adverse events. Primary outcome measures were apnea-hypopnea index (AHI) and 4% oxygen desaturation index (ODI) evaluated by PSG.

Results: A total of 126 participants (21 females) received an implanted system. Average age was 54.5 ± 10.2 yrs and BMI was 28.4 ± 2.6 kg/m². Median AHI and ODI was 29.3 and 25.4 at baseline, and 9.0 and 7.4 at 12 months, and 9.7 and 8.6 at 18 months. Both AHI and ODI reduced significantly at 12 months from baseline ($p < 0.001$) with no further

change to 18 months. Percent of participants with AHI less than 15 was 65% at 12 months and 69% at 18 months. There were three unrelated deaths. Two participants required a device repositioning to resolve discomfort at the device location at 1 and 14 months, respectively. One participant requested an explant before 12 months.

Conclusion: Upper airway stimulation demonstrated a sustained safety profile and reduction of AHI and ODI at 18 months of follow up.

Support (If Any): Inspire Medical Systems, Inc.

0303

EFFICACY AND TOLERANCE OF A CUSTOM-MADE MANDIBULAR REPOSITIONING DEVICE FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA

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Introduction: Guidelines recommend mandibular repositioning devices (MRDs) as primary therapy in patients with mild-to-moderate obstructive sleep apnea (OSA). However, very few studies have specifically assessed the long-term efficacy of MRDs in OSA patients noncompliant with continuous positive airway pressure (CPAP). The ORCADES trial, a French prospective multicenter observational cohort study, is evaluating the clinical benefits of a custom-made MRD over 5 years in 360 OSA patients who refused or did not tolerate CPAP. Interim results are presented.

Methods: Eligible OSA patients fitted with a custom-made MRD (Cad-Cam; Narval) had gradual mandibular advancement (MA) titration until the best benefit-risk ratio was achieved. Objective sleep data (polygraphy or polysomnography), symptoms, quality of life, side effects and compliance were evaluated. Treatment success was defined as a $\geq 50\%$ decrease from baseline in the apnea-hypopnea index (AHI).

Results: To date, 143 patients have undergone the 3-month assessment (71% male, age 53 ± 12 years, body mass index 27 ± 4 kg/m², AHI 29 ± 15 /h, 41% AHI > 30 /h [43 ± 11 /h], 59% AHI 5 - 30 /h [19 ± 7 /h]). Mean final MA was 7 ± 2 mm (75% of maximum MA; 2 ± 1 titrations). Mean MRD usage was 6.7 hours/night on a mean of 6.6 days/week. 120/143 patients (84%) had a $\geq 50\%$ reduction in AHI, irrespective of baseline AHI severity. Mean AHI was reduced to 11 ± 11 /h and AHI was < 10 in 63% of patients. Oxygen desaturation index and Epworth Sleepiness Scale score decreased significantly, from 21 ± 17 to 8 ± 10 and from 12 ± 5 to 8 ± 5 , respectively. Loud snoring disappeared in 90% of patients affected. Nocturnal polyuria and sexual dysfunction resolved completely in $> 50\%$ of patients. Quality of life and fatigue score improved significantly. Fewer than 5% of patients stopped treatment early because of side effects.

Conclusion: Custom-made MRDs can have a significant role in the management of mild-to-severe OSA patients who are intolerant of, or have an inadequate response to, CPAP.

Support (If Any): ResMed.

0304

EFFECT OF CONTINUOUS POSITIVE AIRWAY PRESSURE ON BLOOD PRESSURE IN RESISTANT HYPERTENSION AND HYPERTENSION IN A LARGE CLINIC-BASED COHORT

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Introduction: Real-world effectiveness data of sleep disordered breathing (SDB) treatment in clinic-based cohorts is sparse as is extent of SDB treatment reduction on blood pressure (BP) profiles in resistant hypertension (RHTN) versus hypertension (HTN). We hypothesize that continuous positive airway pressure (CPAP) use in SDB reduces BP significantly in RHTN and HTN in large clinic-based cohort.

Methods: Electronic medical records review was performed focused on HTN and RHTN (BP above goal despite administration of three antihypertensive agents including diuretic). We analyzed data from outpatient sleep clinic visits, including baseline visit before initiation of CPAP therapy and any subsequent visits in the following year. We estimated change in BP between baseline and the year following CPAP initiation using multivariable mixed linear models for three BP outcomes (systolic, diastolic, and mean arterial), adjusting for RHTN status, age, sex, race, body mass index, cardiac history, and diabetes and correlation between repeated measures.

Results: Of 818 patients in the sample [median 1 follow-up visit, (1-13 visits)], 283 (28.3%) met the criteria for RHTN at baseline (age: 57.3 ± 12 years, 52.9 % male, BMI 36.2 ± 9.06). In fully adjusted models, in the year following CPAP initiation, there was a statistically significant decrease in systolic (3.00 mmHg, 95%CI: 1.71, 4.29), diastolic (2.22, 95%CI: 1.51, 2.93), and mean arterial (2.48 mmHg, 95%CI: 1.68, 3.28) pressures; this improvement did not differ based on RHTN status, but RHTN patients had higher pressure overall ($p < 0.001$) in the adjusted models, most notably for systolic BP (4.55 mmHg, 95%CI: 2.2, 6.9).

Conclusion: Among patients with SDB and HTN, including RHTN, CPAP treatment was associated with decreases in BP, most pronounced for systolic BP in the outpatient setting. These clinic-based effectiveness data corroborate RHTN clinical trial efficacy data in terms of effect of SDB treatment on BP outcomes.

0305

ABNORMAL BRAIN BIOENERGETICS DURING RESTING WAKEFULNESS ARE RELATED TO NEUROBEHAVIOURAL DYSFUNCTION IN PATIENTS WITH SEVERE OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is a well established cause of impaired daytime functioning. However, there is a complex inter-individual variability in the neuroanatomical and neurobehavioural deficits in adult OSA. We previously reported defects in brain bioenergetics during apneic sleep in patients with severe OSA. In this study, we used neuroimaging techniques to investigate whether poor brain bioenergetics during resting wakefulness were related to neurobehavioural decrements in OSA.

Methods: Patients with severe OSA were monitored by actigraphy for 4 nights prior to the study. They attended the sleep laboratory in the

evening and were kept awake over-night. Performance testing on the psychomotor vigilance task (PVT, 10-min sustained attention task) occurred at 21:00, 23:00, 01:00, 03:00 and 05:00. We assessed brain bioenergetics (inorganic phosphate/adenosine tri-phosphate ratio, Pi/ATP) in the temporal lobe during resting wakefulness at 07:00 in a 1.5T MRI scanner using phosphorous magnetic resonance spectroscopy (31P MRS) techniques. Results reported are mean \pm standard deviation.

Results: We studied 13 males with severe OSA (age 49 ± 11 yrs, BMI 33 ± 7 kg/m², respiratory disturbance index [RDI] 77 ± 22 h⁻¹). A higher Pi/ATP ratio in the brain (poorer brain bioenergetics) was significantly correlated with worse PVT performance across the testing period (average number of lapses greater than 500 ms, $r = 0.59$, $p = 0.03$). In contrast, the conventional RDI measure of disease severity was not significantly correlated with PVT performance.

Conclusion: Poorer brain bioenergetic activity was related to worse PVT performance in these patients. Neuroimaging appears to provide more accurate objective correlates of negative functional effects in OSA and to predict inter-individual variability. We speculate that better or adaptive brain bioenergetics may protect a patient from the insult of repetitive hypoxia / sleep fragmentation. This may provide insight into why some patients with severe OSA are relatively asymptomatic compared with others.

Support (If Any): This work was supported by the Australian National Health and Medical Research Council, Project Grant ID: 253792.

0306

COMMON VARIANT-BASED HERITABILITY ESTIMATES OF OBSTRUCTIVE SLEEP APNEA-RELATED TRAITS IN THE MESA AND MROS STUDIES

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Introduction: The genetic architecture of complex traits such as obstructive sleep apnea remains largely unknown. While individually significant GWAS SNPs have typically explained a small fraction of heritability in polygenic traits, a substantial fraction of the missing heritability has been explained by leveraging shared identity-by-descent segments of SNPs in distantly related individuals within a population. Genetic heritability estimates can inform the choice of phenotype used in GWAS and quantify small genetic contributions that fail to exceed stringent GWAS multiple-testing thresholds. We quantified the phenotypic variance of the apnea hypopnea index (AHI) and related endophenotypes explained by common SNPs using the mixed model implemented in the Genome-wide Complex Trait Analysis program (GCTA).

Methods: 2,850 European-Americans from the Multi-Ethnic Study of Atherosclerosis ($n \geq 695$) and Osteoporotic Fractures in Men ($n \geq 2,155$) cohorts with overnight at-home polysomnography were examined for measures of AHI, arousal index (AI), and average/minimum oxygen saturation (SaO₂; NREM, REM, and combined). Cohort, age, sex, and 10 population principal components were used as covariates. Estimates of the phenotypic variance (h²g) explained by common ($\geq 1\%$ MAF) autosomal SNPs were calculated using GCTA with and without adjustment for BMI.

Results: The most heritable trait as ascertained by common autosomal SNPs was AHI across the night (h²g (SE) 0.38 (0.11), $p = 0.0002$; BMI-adjusted 0.30 (0.11), $p = 0.004$). The most heritable SaO₂ and AI traits

were minimum SaO₂ within REM (0.27 (0.11), $p = 0.004$; BMI-adjusted 0.22 (0.11), $p = 0.016$) and AI within NREM (0.34 (0.12), $p = 0.002$; BMI-adjusted 0.31 (0.12), $p = 0.004$) respectively.

Conclusion: Common SNP-related narrow-sense heritability of AHI suggests that a large fraction of unidentified genetic architecture remains. This estimate was comparable to a previous Cleveland Family Study estimate using family phenotype data (0.37). While AHI is highly heritable, other phenotypic data including indices of overnight hypoxemia and fragmentation also are heritable, and their analysis may contribute to identifying genetic determinants of OSA.

Support (If Any): 5R01HL113338-02, 2T32HL007901-16.

0307

SLEEP APNEA AND HEAVY VEHICLE CRASHES: A CASE-CONTROL STUDY

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Introduction: Previous case-control studies have observed that private drivers with obstructive sleep apnea (OSA) have a higher motor vehicle crash risk than controls. Although the prevalence of OSA is high in heavy vehicle (HV) drivers, there are no convincing data supporting a higher crash risk in these professional drivers. In order to better determine whether OSA increases crash risk in HV drivers, we conducted a case-control study comparing HV drivers who had recently crashed and those who had not.

Methods: 530 HV drivers with a recent non-fatal crash reported to police and 517 HV drivers with no crash history were interviewed for a range of demographic information including the Epworth Sleepiness Scale (ESS) and Multivariable Apnea Prediction Index (MAPI). A previously validated nasal flow monitor (Flow WizardTM, DiagnoseIT, Sydney, Australia) was posted to drivers and worn for one night to investigate OSA and returned by post.

Results: No significant differences in ESS ($p = 0.15$), flow monitor AHI ($p = 0.14$), body mass index (BMI) and age were observed between cases and controls. There was a significant difference in MAPI (higher risk of OSA for controls, 38% vs. 47%, $p = 0.02$). Unknown data (34.4%) included refusal to have test (9.3%), failure to be able to deliver device (8.1%), device lost (6.9%) or insufficient data recorded (10.4%). There were no significant differences in BMI (30.6 vs. 31.1, $P = 0.4$) or age (46.4 vs. 45.6, $P = 0.36$) between those drivers who did and did not complete the flow monitor test.

Conclusion: Despite the high prevalence of OSA, self-report by ESS or MAPI or objective AHI by a nasal flow monitor were not associated with non-fatal heavy vehicle crashes. These data do not exclude the possibility that other non-AHI OSA-related factors such as individual vulnerability to sleepiness are associated with crash risk.

0308

A GENOME-WIDE ASSOCIATION STUDY OF OBSTRUCTIVE SLEEP APNEA-RELATED TRAITS IN MULTIETHNIC COHORTS

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Introduction: Obstructive sleep apnea (OSA) is a common disease characterized by recurrent episodes of pharyngeal obstruction during sleep, often associated with profound hypoxemia and sleep fragmentation. Little is currently known about the genetic architecture of OSA, in part due to the need to collect overnight data at sizes sufficient to power genome-wide association studies. We hypothesized that increased sample size, dense imputed genotypes, and rigorous analysis of OSA endophenotypes would identify genetic variants for quantitative traits for OSA. Here we present initial results from our ongoing OSA meta-analysis based on five cohorts and up to 5,892 African-Asian-European- and Hispanic-American individuals. The final analytical sample is expected to exceed 10,000 individuals.

Methods: Individuals from the Cleveland Family, Framingham Heart, Multi-Ethnic Study of Atherosclerosis, Osteoporotic Fractures in Men, and Starr County Health studies with overnight sleep apnea testing were analyzed. Genotypes from Affymetrix and Illumina chips were imputed using the 1000 Genomes Phase 1 reference panel. Up to 11.6 million SNPs passing quality control were tested for association with the apnea hypopnea index and average oxygen saturation (overnight and within REM and NREM, as available). Models adjusted for age, sex, and 10 population principal components were analyzed with and without BMI adjustment using an additive genetic model in SNPTEST or GWAF (for family data). Fixed-effects inverse variance meta-analysis was performed using METAL and genomic control was applied.

Results: Several cohort-specific GWAS significant ($p < 5 \times 10^{-8}$) associations were detected, with several associations more significant after BMI adjustment. Initial meta-analysis identified promising signals in several genes, including PRDM5, a transcription factor influencing craniofacial and extracellular matrix development.

Conclusion: Analysis of several quantitative sleep apnea traits across multi-ethnic cohorts identify promising genetic signals for the overall AHI as well as metrics that quantify NREM- and REM-dependent sleep apnea and overnight hypoxemia.

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0309

RELATIONSHIP OF AIR POLLUTION TO SLEEP DISORDERED BREATHING AND SLEEP DISRUPTION: THE MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS SLEEP AND AIR STUDIES

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Introduction: Air pollution is associated with cardiovascular mortality and may promote autonomic dysfunction. A prior study identified as-

sociations between short-term variation in outdoor particulate pollutants, sleep disordered breathing, and sleep continuity. We evaluated relationships between participant-level estimates of long-term ambient-derived pollution exposure, sleep apnea, and sleep disruption.

Methods: The current study used the 10-year follow-up exam from the Multi-Ethnic Study of Atherosclerosis (MESA), a community-based 6-center cohort study. Exposure to air pollutants including PM_{2.5} and oxides of nitrogen were estimated at participants homes using spatio-temporal models based on cohort-specific monitoring, averaged for 5 years prior to comprehensive sleep evaluation. PM_{2.5} estimates accounted for the infiltration fraction of outdoor pollutants and time spent indoors. We used multivariable regression to evaluate associations between PM_{2.5} and NO_x exposure with home polysomnography measures including the apnea hypopnea index (AHI), hypoxemic burden, and oxygen desaturation index, as well as actigraphy-determined 7-day average sleep efficiency. We adjusted for race, income, education, obesity, gender, age and site.

Results: 2,040 participants (age 68.6 ± 9.2 years; 37% white, 11% Asian, 28% black and 23% Hispanic) had both sleep assessments and air pollution exposure estimates. Median sleep efficiency was 90.4% (IQR 88.0%-92.5%). In adjusted models, NO_x levels in the highest quartile compared to the lowest were associated with a 0.72% (95% CI -1.14, -0.29) and NO₂ a 0.80% (95% CI -1.12, -0.49) decrease in sleep efficiency. Oxides of nitrogen and PM_{2.5} estimates were not associated with AHI, hypoxemic burden or desaturation index.

Conclusion: Long-term residential air pollution exposure was not associated with sleep-disordered breathing. Higher levels of traffic-related air pollution are associated with more sleep disruption. Further research is needed to identify whether the latter associations are attributable to NO_x, noise, other pollutants or environmental exposures that co-vary with traffic.

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0310

THE EFFECT OF SNORING TIME AND THE APNEA/HYPOPNEA INDEX ON CHANGES IN CAROTID ATHEROSCLEROSIS OVER 6 YEARS

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Introduction: There is continuing controversy about whether snoring can cause cardiovascular disease, independent of obstructive sleep apnea (OSA) and other cardiovascular risk factors. The purpose of the present study was to examine the effect of and interaction between objectively measured snoring time and the apnea/hypopnea index (AHI) as potential risk factors for changes in carotid atherosclerosis over 6 years.

Methods: 213 men and 91 women who underwent a full-night home-based sleep study using a portable sleep device (Nox-T3, Noxmedical) were enrolled. Snoring sound was objectively measured by a built-in microphone and manually annotated. Percentage of snoring time was calculated by dividing the total duration of three or more consecutive snore events by total sleep time and multiplying by 100. According to snoring time, subjects were divided into three snoring groups: non/mild (snoring time < 25%), moderate (25-50%), and heavy snoring (> 50%). Carotid atherosclerosis was defined as mean and maximal intima-media

thickness (IMT) on both common carotid arteries, measured by ultrasound from 2005 to 2012 biennially.

Results: The three snoring groups were matched by age, body-mass index, cholesterol, blood pressure, and glucose levels, using weights from generalized boosted-propensity score models. There was a significant interaction ($p = .01$) between AHI and snoring groups on changes in carotid IMT over 6 years in women only; not in men. By grouping AHI into three categories ($AHI < 5$, $5 \leq AHI < 15$, $AHI \geq 15$) among those women with high AHI ($AHI \geq 15$), snoring was a significant predictor of maximal IMT ($\beta = 0.003$, $p = .04$), showing that increased snoring time was associated with accelerated carotid atherosclerosis over 6 years for those women with moderate to severe OSA only. No other statistically significant relationships were found in low-AHI groups. AHI was a significant predictor of an increase in mean and maximal IMT over 6 years in mild and heavy snorers, but not in moderate snorers in women. Snoring time and AHI did not appear to have a significant relationship with carotid atherosclerosis in men.

Conclusion: Both AHI and snoring time were found to be independent risk factors for acceleration in carotid atherosclerosis over time in women, but not in men. However, the snoring effect was shown in moderate-to-severe OSA only, whereas the AHI effect was significant in mild and heavy snorers.

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0311

ASSOCIATION BETWEEN SLEEP DISORDERED BREATHING AND THE SUBSEQUENT DIAGNOSIS OF DIABETES IN YOUNG VETERANS: A RETROSPECTIVE COHORT STUDY

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Introduction: There is accumulating evidence for an association between sleep disordered breathing (SDB) and diabetes mellitus (DM). This study explores the relationship between diagnosed SDB and subsequent diagnosis of DM in a cohort of young patients without morbid obesity.

Methods: A retrospective chart review was conducted on consecutive cases referred for a clinical sleep study at the Greater Los Angeles Veterans Affairs Medical Center between 1/1998 and 12/2004. Patients younger than 45 years, with body mass index (BMI) $< 35 \text{ kg/m}^2$ and at least 5 years follow-up who did not have DM at that time of the sleep study were identified. All patients had a polysomnogram or home sleep test. The presence of DM at baseline and follow-up was determined from the medical record. A Fischer's exact test was used to compare rates of DM at follow-up based on presence versus absence of SDB at baseline. Exact logistic regression with SDB and obesity ($BMI > 30 \text{ kg/m}^2$) as predictors of DM was performed.

Results: 119 patients met inclusion/exclusion criteria and did not have DM at baseline. 63.9% of patients had SDB while 36.1% did not. Mean age was 36.3 years (SD 5.4), mean BMI was 29.1 kg/m^2 (SD 3.6) and mean follow-up time was 10.9 years (SD 2.6). Those with SDB were older (37.6 versus 33.0 years) and had higher BMI (30.2 versus 27.3 kg/m^2) p 's < 0.01 . At follow-up, 19 patients (25%) with SDB developed DM, while 3 (7%) without SDB developed DM ($p = .015$). Odds of developing DM were 4.8 times higher for patients with SDB ($p < 0.05$), but there was no additional risk associated with obesity (OR = 0.78; $p = 0.86$).

Conclusion: Among veterans under age 45 years, SDB was associated with the subsequent diagnosis of DM. This study suggests even young SDB patients may be at high risk for the metabolic consequences of SDB.

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0312

EFFECT OF OBSTRUCTIVE SLEEP APNEA TREATMENT ON SYSTEMIC INFLAMMATION: RESULTS OF THE SLEEP APNEA STRESS STUDY (SASS) RANDOMIZED CONTROLLED TRIAL

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Introduction: Up-regulation of systemic inflammation has been implicated in cardiovascular disease and is a recognized consequence of obstructive sleep apnea (OSA). We hypothesize that treatment of OSA with continuous positive airway pressure (CPAP) will result in improvement in markers of inflammation.

Methods: A parallel randomized control trial (NCT 00607893) was performed involving participants with moderate to severe OSA ($AHI \geq 15$). Following a 4 week washout period, baseline and 2-month follow-up standardized fasting morning blood work was collected. Assays for serum interleukin-6 (IL-6) (pg/mL) and soluble interleukin-6 receptor (sIL-6R) (ng/mL) (Quantikine HS IL-6 and IL6R immunoassays; R&D with intralaboratory coefficients of variation being 9.1% and 6.6% respectively) were performed. The t-test was used to examine percentage change from baseline to 2-months of IL-6 and sIL-6R in the two groups.

Results: Of the subjects randomized, 143 subjects completed the study; 72 in the CPAP and 71 in the Sham CPAP group. The CPAP and Sham CPAP groups were well-matched respectively with mean age of 37.3 ± 8.1 and 37.3 ± 8.3 , male gender 54.7% and 52.7%, Caucasian 49.3% and 55.4%, mean BMI of 41.2 ± 3.8 and $41.0 \pm 4.0 \text{ kg/m}^2$, and median AHI was 19.1 and 20.5. At the end of the 2-month intervention, there was a statistically significant difference in sIL-6R levels in CPAP compared to sham CPAP: (percent change: -2.87 ± 1.76 and 2.78 ± 1.83 respectively, $p = 0.028$). No difference was found in IL-6 levels in either group compared to baseline.

Conclusion: Soluble IL-6R, but not IL-6 was reduced with CPAP compared to sham CPAP. These findings are consistent with our prior work demonstrating significant associations with increasing OSA severity and increasing sIL-6R but not IL-6 levels after taking into consideration obesity. These findings reveal unique insights into the underlying mechanisms of OSA biology and provide a basis to target OSA therapy to mitigate cardiovascular risk.

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0313

IMPACT OF SLEEP DISORDERED BREATHING TREATMENT ON SUBJECTIVE PATIENT REPORTED OUTCOMES IN A LARGE HYPERTENSION CLINIC-BASED COHORT ENRICHED WITH RESISTANT HYPERTENSION

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Introduction: Patient reported outcomes (PROs) have been poorly characterized in those who have sleep disordered breathing (SDB) and hypertension (HTN) or resistant hypertension (RHTN), which is of interest as they may demonstrate differing subjective responses to SDB treatment. We interrogated a large-clinic based cohort to address the hypothesis that significant improvement in PROs with continuous positive airway pressure (CPAP) in SDB and RHTN or HTN will be observed.

Methods: Retrospective analysis (February 2008 to July 2013) using electronic medical records were performed focused on HTN and RHTN (BP above goal despite using three or more antihypertensive including diuretic) and PROs during outpatient visits, sleep clinic patients completed questionnaires. PROs were defined as depression (Patient Health Questionnaire-9, PHQ-9), fatigue (Fatigue Severity Scale, FSS), and sleepiness (Epworth Sleepiness Scale, ESS) collected at baseline and all visits within a year following CPAP initiation for SDB. We estimated the change in each PRO between baseline and the year following CPAP initiation using a multivariable linear mixed model for each PRO, adjusting for baseline RHTN status, age, sex, race, body mass index, cardiac history and diabetes and correlation between repeated measurements on a patient.

Results: Of 818 patients with HTN [median 1 follow-up visit, (1-13 visits)], 283 (28.3%) met the criteria for RHTN at baseline (age 57.3 ± 12 years, 52.9 % male, BMI 36.2 ± 9.06). In fully adjusted models, there was a significant improvement (all $p < 0.001$) in depression (PHQ-9; 1.90 points; 95%CI: 1.59, 2.21), fatigue (FSS; 3.77 points, 95%CI: 2.97, 4.57), and sleepiness (ESS; 2.06 points, 95%CI: 1.81, 2.31); improvement and overall PRO levels were not significantly different in RHTN patients, compared to HTN patients.

Conclusion: A novel finding is the consistent improvement of patient-reported depression, fatigue, and sleepiness in a clinic-based population of HTN with similar improvement observed in those with RHTN.

0314

THE ASSOCIATION BETWEEN CHANGE IN CLINICAL OUTCOME MEASURES AND APNEA HYPOPNEA INDEX CORRECTED FOR CPAP USE

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Introduction: The change in clinical outcome measures with continuous positive airway pressure (CPAP) treatment for sleep apnea often correlates poorly with the corresponding change in surrogate polysomnography measures. However, the amount of time that CPAP is used is rarely factored into analyzing these associations, which may in part explain the discordance. We aim to test the hypothesis that clinical and surrogate outcomes of CPAP treatment are better correlated when corrected for CPAP use.

Methods: Five validated, patient-centered clinical outcome measures of baseline sleep symptoms and quality-of-life were collected via questionnaire from patients undergoing initial diagnostic polysomnography. Those treated with CPAP completed the questionnaires 6 months later. Baseline apnea-hypopnea index (AHI) was measured in the initial polysomnography and treated AHI (at pressure prescribed) was measured in the titration polysomnography. Objective CPAP use was downloaded and used to calculate the corrected mean nightly AHI with a previously published formula. Spearman's coefficient was used to measure the correlation between the change in each clinical measure and the change in AHI uncorrected and corrected for CPAP use. Zeiger's Z test was used to test the difference between the uncorrected and use-corrected correlations.

Results: The final analysis included 558 subjects. All correlations were less than 0.3. Two of the five clinical measures were significantly correlated with the uncorrected change in AHI ($|r| = 0.10-0.13$, both $p < 0.01$), while four of the five clinical measures were significantly correlated with the use-corrected change in AHI ($|r| = 0.11-0.26$, each $p < 0.02$). The use-corrected AHI correlation was significantly stronger than the uncorrected AHI correlation with two clinical outcome measures (both $p < 0.03$).

Conclusion: Correction for CPAP use yielded overall small but statistically significant improvements in the correlations between clinical and surrogate (AHI) outcomes of CPAP treatment for sleep apnea.

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0315

THE EFFECT OF CPAP AND PDE-5 INHIBITOR ON ARTERIAL STIFFNESS AND ENDOTHELIAL FUNCTION IN MEN WITH OSA AND ERECTILE DYSFUNCTION: A RANDOMISED CONTROLLED STUDY

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Introduction: Erectile dysfunction (ED) and obstructive sleep apnoea (OSA) often co-exist and are both associated with vascular dysfunction. We aimed to determine if a low daily dose of a PDE-5 inhibitor or CPAP therapy or both used concurrently was effective in improving arterial stiffness and endothelial function, in men with both OSA and ED.

Methods: 49 men with OSA (AHI > 20) and ED (International Index of Erectile Function questionnaire IIEF-ED < 26) were randomised to 12 weeks of CPAP or sham CPAP as well as 10 mg daily Vardenafil or placebo in a 2 × 2 factorial design. Pulse Wave Analysis (PWA) assessed arterial stiffness and endothelial function was assessed by Peripheral Arterial Tonometry (PAT) and in a subset (n = 25) using Flow Mediated Dilatation (FMD).

Results: CPAP, compared to sham CPAP, improved the central augmentation index in PWA (-6.5%, $p < 0.001$) as well as the peripheral diastolic pressure ($p = 0.04$), and trended toward improving central augmentation pressure ($p = 0.086$) and central diastolic pressure ($p = 0.053$). CPAP also improved the augmentation index in PAT (-6.08% $p = 0.008$) but not the reactive hyperemia index. Similarly, brachial dilatation in FMD did not change with CPAP compared to Sham CPAP. Vardenafil, compared with placebo, improved the reactive hyperemia index ($p = 0.046$) but did not change augmentation index of the PAT, nor any parameters

of the FMD or PWA. The use of both treatments simultaneously did not result in any additional benefit in any parameter.

Conclusion: CPAP may improve vascular function in terms of arterial stiffness and blood pressure in men with OSA & ED. Daily dose Vardenafil may be useful to improve peripheral endothelial function, but larger studies will need to confirm this. Vardenafil does not improve arterial stiffness. Improvements in vascular function through the use of CPAP may improve long term outcomes.

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0316

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) REDUCES CENTRAL BLOOD PRESSURE AND ARTERIAL STIFFNESS: A RANDOMISED CONTROLLED STUDY

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Introduction: OSA is associated with excess cardiovascular morbidity and mortality. Randomised controlled trials have shown CPAP improves arterial stiffness, an intermediate risk factor for cardiovascular disease. There are no randomised controlled trials examining the effect of CPAP on the diurnal variations of central blood pressure and arterial stiffness. We aimed to investigate the effect of CPAP treatment on central blood pressure and arterial stiffness in patients with moderate or severe OSA. **Methods:** Thirty-eight CPAP naïve adults received therapeutic and sham CPAP in random order for 8 weeks each with an intervening one month washout. Peripheral blood pressure, central blood pressure, arterial stiffness (Augmentation Index) and a surrogate measure of pulse wave velocity (time to reflection) were measured by pulse wave analysis at the end of both treatment arms on the evening before (8 PM) and morning after (6 AM) overnight.

Results: Compared to sham, CPAP significantly reduced peripheral systolic (mean difference [95%CI] -4.1 mmHg [-6.8 to -1.4], $p = 0.004$), peripheral diastolic (-3.8 mmHg [-6.0 to -1.5], $p = 0.001$), central systolic (-4.1 mmHg [-6.7 to -1.4] $p = 0.003$) and central diastolic (-3.9 mmHg [-6.1 to -1.6], $p = 0.0009$) blood pressure. These effects were independent of measurement time (time*treatment interaction terms all $p > 0.1$). There were no differences in peripheral or central pulse pressure (both $p = \text{NS}$). In contrast, relative to sham, CPAP decreased the augmentation index and increased the time to reflection across the night (both time*treat interaction $p = 0.099$). This was indicated by reduced arterial stiffness and increased time to reflection (suggesting a decrease in pulse wave velocity) on CPAP in the morning (-2.5% [-4.3 to -0.3], $p = 0.03$ and 6.0 [2.0 to 10.0], $p = 0.0036$) but not in the evening reading (0.12 [-2.2 to 2.4], $p = 0.91$) and (1.4 [-2.6 to 5.3], $p = 0.50$ respectively).

Conclusion: Improvements in arterial stiffness with CPAP occur in a time-dependent manner whereas improvements in central and peripheral blood pressure were independent of diurnal variation.

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0317

CONTINUOUS POSITIVE AIRWAY PRESSURE RAPIDLY IMPROVES BLOOD PRESSURE AND ARTERIAL CONSTRICTION IN YOUNG ADULTS

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Introduction: Obstructive sleep apnea (OSA) is associated with cardiovascular disease risk. Continuous positive airway pressure (CPAP) treatment may reduce this risk, but the mechanisms, time course, and durability of its benefit are not known. Previous research has been confounded by non-compliance with CPAP and competing risk factors.

Methods: Individuals ≤ 50 years old with newly diagnosed OSA were evaluated before CPAP therapy, after 12 weeks of CPAP, and 1 week after CPAP withdrawal. Carotid to radial artery pulse wave velocity (PWVc-r), and central aortic blood pressures (cBP) were obtained by applanation tonometry. Brachial artery (BA) size and flow-mediated dilation (FMD) were measured with B-mode ultrasound. Subjects were categorized based on CPAP compliance: ≥ 4 (high compliance) or < 4 (low compliance) hours/night. Subject responses and group differences were compared with t-Tests.

Results: Forty-seven subjects were mean (standard deviation) 40.8 (6.7) years old (77% male). High compliance subjects ($n = 37$) used CPAP 6.1 (1.2) hours/night, while low compliance subjects ($n = 10$) used it 2.4 (0.9) hours/night ($p < 0.001$). High compliance subjects showed significant improvements in systolic (-3.2 mmHg, $p = 0.022$) and diastolic (-4.7 mmHg, $p < 0.001$) cBP, BA size (+0.2 mm, $p < 0.001$), and PWVc-r (-0.38 m/s, $p < 0.003$). No significant changes were observed in the low compliance subjects. After 6 days of CPAP withdrawal, high compliance subjects experienced rebound increases in diastolic (+1.8 mmHg, $p = 0.057$) cBP, Augmentation Index (+2.4%, $p < 0.009$), and vasoconstriction (BA -0.06 mm, $p = 0.028$).

Conclusion: In young adults with newly diagnosed OSA, compliance with CPAP therapy rapidly improves cBP, PWVc-r, in association with vasodilation, but start to reverse after 1 week CPAP withdrawal, likely due to changes in sympathetic tone. These improvements are only seen in compliant individuals. Initiation and compliance with CPAP helps treat hypertension and may prevent its complications in patients with OSA.

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0318

PAP USE CRITERIA AND CHANGE OF HEMOGLOBIN A1C

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Introduction: It is unclear whether Medicare-defined, positive airway pressure (PAP) adherence has any clinical impact on glycemic control. We evaluated PAP use as per Medicare criteria (≥ 4 hrs/night, $\geq 70\%$ of nights) and by %days used in 3 patient groups, defined by hemoglobin A1c (HbA1c): patients without diabetes (no-DM, HbA1c < 5.7), with pre-DM (HbA1c = 5.7-6.4), and with DM (prior diagnosis or HbA1c > 6.4).

Methods: 82 newly-diagnosed OSA patients (67% female, mean age = 54.5 yrs) were evaluated before PAP treatment (T1) and 3-months with PAP treatment (T2). Clinical measures included HbA1c, body mass index (BMI), and systolic and diastolic blood pressure (SBP, DBP). PAP use was evaluated according to Medicare criteria and by %days used, grouped as low use ($< 25\%$ ile; use $< 44\%$ of days), middle use (between

25-75%ile), and high use (> 75%ile; use > 93% of days). Statistical methods included linear regression analyses, t-tests, and ANOVA.

Results: At T1, positive correlations were found between HbA1c and BMI ($p = 0.03$), and HbA1c and AHI ($p = 0.002$) while controlling for age ($F = 7.75$, $R^2 = 0.23$, $p < 0.001$). At T2, there was an overall increase in HbA1c, though this was not clinically significant ($T1 = 6.05 \pm 1.1$, $T2 = 6.19 \pm 1.2$, $p = 0.002$). No significant changes occurred with BMI ($p = 0.26$), SBP ($p = 0.22$), or DBP ($p = 0.72$). Among patient groups, there were no differences in change of HbA1c ($p = 0.93$). PAP use did not affect HbA1c, using Medicare criteria ($p = 0.58$) or %days used ($p = 0.7$). However, there was a significant interaction between patient group and %days used ($p = 0.045$), suggesting that HbA1c is affected differently according to adherence definition and DM status.

Conclusion: Our pilot results suggest that PAP use as defined by %days used, but not as defined by current Medicare criteria, may influence HbA1c outcomes. Future research may examine the utility of redefining PAP-adherence criteria to determine if there are clinically significant effects on glycemic control in different patient populations.

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0319

EFFECTS OF CONTINUOUS POSITIVE AIRWAY PRESSURE ON MEASURES OF ARTERIAL STIFFNESS IN OBSTRUCTIVE SLEEP APNEA: RESULTS OF THE SLEEP APNEA STRESS STUDY RANDOMIZED CONTROLLED TRIAL

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Introduction: Although clinical trials have demonstrated consistent improvements in blood pressure (BP) with continuous positive airway pressure (CPAP) in obstructive sleep apnea (OSA), the effect on measures of vascular stiffness has not been as rigorously examined. We postulate that CPAP results in improvement in measures of arterial stiffness in a randomized controlled trial.

Methods: We conducted a parallel randomized controlled trial (NCT00607893) of 2-month CPAP vs sham-CPAP in patients with moderate to severe OSA (Apnea-Hypopnea Index ≥ 15) to examine effects on intermediate cardiovascular outcomes. At baseline and 2-month follow-up exams, polysomnography, AM/PM collection of BP and applanation tonometry (SphygmoCor; PWV Medical, Sydney, Australia), to measure augmentation index (AI) and pulse wave velocity (PWV, cm/s), were performed. Mixed effects models were used to examine percentage change from baseline to 8 weeks of evening and morning BP, AI and PWV measures between the groups.

Results: Of 153 participants, 76 were randomized to CPAP and 77 to sham-CPAP. At baseline, both groups had similar characteristics with overall: age (51 ± 11.7 years), males (54%), Caucasian (52%) and body mass index (37.2 ± 8.1 kg/m²). We found a statistically significant difference between CPAP and sham-CPAP groups respectively, in the percentage change of the following morning measures: systolic BP (-2.51 ± 0.97 , 0.33 ± 0.98 $p = 0.042$), diastolic BP (-2.15 ± 1.33 , 1.88 ± 1.34 $p = 0.035$) and absolute difference in AI (6.5 ± 1.4 , -0.2 ± 1.3 $p = 0.009$).

There were no significant changes in the evening BP, AI and PWV measures between the groups.

Conclusion: The use of CPAP in moderate to severe OSA resulted in improvements in morning systolic BP and AI. The improvement of morning and not evening vascular measures suggests that reversal of overnight OSA-induced physiologic stressors results in direct improvements in morning vascular function which does not appear to persist in the evening.

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0320

CPAP COMPLIANCE: EFFECTS OF CPAP ADAPTATION PERIODS, OSA SEVERITY AND OTHER PARAMETERS ON CPAP COMPLIANCE

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Introduction: Although the most effective treatment option for obstructive sleep apnea (OSA) is continuous positive airway pressure (CPAP), a significant proportion of patients are unable to adhere and comply with its consistent use. The objective of this study is to explore the various parameters and conditions that the patients experience before the initiation of CPAP treatment that may help to predict and influence the likelihood of longer term CPAP compliance.

Methods: A retrospective, chart review and survey study was performed; analyzing the CPAP compliance of long term (4-6 months) post CPAP titration and fitting, on a total of 97 patients diagnosed with moderate to very severe OSA. The effects and predictability that OSA severity, Epworth scores, CPAP trial duration prior to titration, sleep efficiency during titration and any co-morbidities prior to treatment have on future CPAP use were analyzed.

Results: A significant proportion of CPAP compliant patients had very severe OSA (AHI > 45), while the majority of non-compliant patients had moderate OSA ($p < 0.04$). Additionally, patients in the severe OSA groups had the highest individual percentage use of CPAP, relative to moderate OSA patients ($p < 0.02$). This study also confirms that an optimal CPAP trial of 7 to 14 days prior to titration is associated with the strongest compliance, relative to shorter and longer CPAP adaptation periods ($p < 0.04$). Finally, results indicated that CPAP compliance was not influenced by pre-existing excessive daytime sleepiness, cardiovascular co-morbidities, nor sleep efficiency during night of titration.

Conclusion: This study confirms the general understanding that the severity of OSA influences the outcome of CPAP compliance. Patients with more severe OSA are more likely to adhere to long term use of CPAP. Furthermore, the duration of pre-CPAP treatment adaptation plays a significant role in determining compliance, with the average 7 to 14 days being an optimal period. The degree of cardiovascular co-morbidities did not influence the patient's decision to the use of CPAP, indicating that more patient's education on relationship between cardiovascular diseases and OSA is needed to further increase compliance. The presence of significant sleepiness before treatment did not enhance the subsequent CPAP use, suggesting the possibility that CPAP may not have a sufficiently positive impact on sleepiness as expected and therefore did not lead to long term adherence and use. A good and completed CPAP titration study resulting from efficient sleep also did not seem to facilitate long term CPAP use in this study.

0321

EFFECTS OF OBSTRUCTIVE SLEEP APNEA ON WEIGHT LOSS OUTCOME: IMPLICATIONS OF GENDER

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Introduction: Weight loss can result in remission or improvement of obstructive sleep apnea (OSA), and is often prescribed to patients. Given the metabolic changes associated with sleep apnea, however, weight loss may be difficult to achieve. To investigate this issue, we examined weight loss outcome in individuals seeking weight loss in consultation with a dietician. We tested the hypothesis that individuals with sleep apnea would have greater difficulty losing weight than those without OSA.

Methods: Participants were 41 obese individuals seeking weight loss through a medical center nutrition clinic program. All participants were recruited following their initial visit with a dietician. Participants reported demographic information and medical history. Baseline height and weight and follow-up weight loss were obtained through medical records. Diagnostic polysomnography was used to determine severity of OSA, measured by the apnea-hypopnea index (AHI). Study exclusion criteria included diabetes and other conditions known to impact weight loss.

Results: Multilevel modeling was used to examine the relationship between AHI and weight loss. Significant AHI by gender, ($p < .05$) and AHI by time, ($p < .01$) interactions were observed. Thus, the effect of AHI on weight loss was moderated by gender and time point. For male participants, greater AHI was related to lower weight loss at six months and one-year follow-up. The opposite pattern was observed in females, however, such that weight loss at six months and one-year follow-up was greater in females with higher AHI. These effects remained significant after controlling for the effects of age, initial BMI, smoking and CPAP use.

Conclusion: These results suggest that males, but not females, with OSA may have more difficulty losing weight. Additional research is needed to determine the mechanisms by which OSA impacts weight loss outcome.

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0322

THE INFLUENCE OF RACE ON THE TRAJECTORY OF CPAP USE DURING THE FIRST 4 WEEKS OF TREATMENT

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Introduction: Studies have shown that blacks with obstructive sleep apnea (OSA) use CPAP less than whites. However, limited research has examined the effects of race on the trajectory of CPAP adherence during the first month of therapy. Our study aim was to determine the influence of race on the trajectory of CPAP adherence during the first 4 weeks of treatment.

Methods: Consecutive CPAP-naïve OSA patients over a four month period ($n = 177$, 40% black) attended the Miami VA CPAP clinic to receive CPAP and complete questionnaires. Patients returned for follow-up and objective adherence download. Weekly averages in minutes for the first 4 weeks of treatment were outcomes. We used longitudinal, mixed-effects modeling to characterize the influence of race on the trajectory of CPAP use.

Results: Results indicated that a quadratic model provided the best fit. No race effect was found in CPAP use at week 1. Thus, race predicting initial status was removed from the model. The estimated conditional model with race as a level 2 predictor is: Adherence = $197^a + 12$ (weeks) – 42^a (weeks*race) – 6^a (weeks²) + 10^a (weeks²*race) ($a = p < 0.05$). Whites used CPAP on average for 197 min at week 1 and increased their use during week 2 by 11 min. Subsequently, whites decreased their use in weeks 3-4. At week 4, whites were using CPAP for 149 minutes. Blacks used CPAP for 197 min during week 1 which was reduced by 30 min during week 2. The weekly reduction in use decelerated over time and by the 4th week blacks were using CPAP for 141 minutes. These results were unchanged adjusting for covariates.

Conclusion: These data indicate that CPAP usage at week 1 and week 4 are similar between blacks and whites but the trajectory of CPAP adherence varies by race. A better understanding of these racially specific adherence curves may help to improve CPAP use.

0323

SLEEP ARCHITECTURE CORRELATES OF SUBJECTIVE SLEEP PERCEPTION IN POSTMENOPAUSAL WOMEN

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Introduction: Menopause is associated with increases in sleep related complaints, including insomnia, obstructive sleep apnea (OSA) and mood disorders with associated sleep disruption. Decreased sleep efficiency seen on the polysomnogram (PSG) may be related to menopause, OSA or aging. We hypothesized that improvement in sleep architecture with treatment of OSA will result in subjective improvements in sleep quality in postmenopausal women as assessed by the Post-PSG Sleep Assessment questionnaire (PPSA).

Methods: 18 postmenopausal women diagnosed with OSA and subsequently treated with Continuous Positive Airway Pressure (CPAP) were studied in a prospective manner. PPSA scores from baseline PSG were compared with those after CPAP titration PSG using the Wilcoxon Signed-Rank Test. Changes in sleep architecture were compared between the PSG studies and correlated with changes in PPSA using simple linear regression.

Results: Trends towards improved perception of sleep quality were noted with improved Sleep Efficiency ($r = 0.61$; $p < 0.05$), decrease in Awake Index ($r = 0.57$; $p < 0.05$), increase in Total Sleep Time ($r = 0.49$; $p < 0.05$), and increased percentage of N3 sleep ($r = 0.49$; $p < 0.05$), but not with changes in REM sleep architecture or absolute amount of N3 sleep. The mean baseline PPSA score was 13.3 [6-26]. The mean post CPAP titration PPSA score was 19.7 [6-30]. The change in PPSA was statistically significant ($p = 0.03$).

Conclusion: Perception of sleep quality in postmenopausal women appears to be more dependent on improvement in sleep efficiency, decreased awakenings, as well as an increased total sleep time, rather than on changes in the total amount of N3 sleep or changes in REM sleep.

0324

EFFECT OF CONTINUOUS POSITIVE AIRWAY PRESSURE ON WAIST CIRCUMFERENCE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Visceral adipose tissue has distinct physiological characteristics and responds to interventions differently from subcutaneous

fat. Measurements of waist circumference are highly correlated with the volume of visceral adipose tissue. Treatment of sleep apnea with CPAP helps to control metabolic syndrome, but the knowledge about the effects of CPAP on visceral adipose tissue is incipient. The present study aims to investigate the long-term effect of sleep apnea treatment with CPAP on waist circumference in patients with sleep apnea.

Methods: Individuals of both genders, older than 18 years with a prescription for CPAP use. All underwent type-I polysomnography at a university-affiliated sleep laboratory. The group using CPAP underwent at least three polysomnographies. The control group consisted of patients who repeated a polysomnography after at least six months and reported not receiving any treatment; the AHI had to continue in the same severity category at the second polysomnography.

Results: Seventy-seven patients were included in the CPAP group and 43 in the control group aged, respectively 51 ± 11 and 48 ± 11 years with AHI of 56 ± 29 and 37 ± 17 /h. Follow up time was, respectively, 2.5 and 2.3 years. Both groups showed a non-significant increase in body mass index. A significant reduction in waist circumference was observed in the CPAP group (-0.8 ± 5.3 cm), comparing with controls (1.5 ± 5.4 ; $P = 0.024$). The binary logistic model to predict decreased waist circumference after follow up period was significant (P_{45} years, $BMI \geq 30$ kg/m², and $AHI \geq 30$). These variables explain 36% of the variance of waist circumference reduction.

Conclusion: Long-term CPAP therapy is associated with a reduction in waist circumference, regardless of sex, age, change in BMI, and basal AHI.

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0325

PREDICTORS OF PAP THERAPY ADHERENCE IN A CLINICAL SAMPLE

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Introduction: Untreated obstructive sleep apnea (OSA) has major health consequences. Positive airway pressure (PAP) therapy is standard treatment for OSA; however, a significant portion of individuals with OSA experience difficulties with PAP therapy adherence. Despite the high prevalence of nonadherence, little is known regarding factors that predict nonadherence. Exploratory analyses were conducted in a clinical sample in order to identify possible factors relevant to PAP adherence.

Methods: 108 records (83 males) were included from archival records collected between 2008 and 2009. Adherence data were included under the following conditions: 1) patients received PAP equipment within 3 months of order date, 2) adherence data were checked within 3 months of start date, and 3) adherence data were monitored for at least 30 days. Individuals were categorized as high-adherent if data revealed use of PAP equipment for at least 4 hours per night on 70% of the nights monitored (congruent with Medicare guidelines). Individuals who did not meet these criteria were categorized as low-adherent. Adherence data also included the apnea-hypopnea index (AHI) during PAP therapy. Individuals also reported pre-treatment depression, anxiety, sleepiness/fatigue, and quality of life via questionnaires. Exploratory one-way ANOVAs were conducted with questionnaire data as the dependent variables and compliance as the independent variable.

Results: Compared to low-adherent individuals, high-adherent individuals reported lower physical difficulties pre-treatment, $F(1,107) = 7.546$, $p < .01$, and showed lower AHI during use of PAP, $F(1,69) = 4.206$, $p < .05$. Results also indicated a marginal difference in pre-treatment emotional well-being between high- and low-adherent individuals, $F(1,66) = 2.933$, $p < .1$, with high-adherent individuals reporting higher pre-treatment emotional well-being.

Conclusion: Preliminary results suggest that PAP adherence may be related to better pre-treatment health, as well as enhanced response to PAP therapy. Clinical implications include identifying patients who may benefit from closer monitoring and subsequent interventions to support PAP adherence.

0326

PATTERNS AND CAUSES OF NONCOMPLIANCE WITH CONTINUOUS POSITIVE AIRWAY PRESSURE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA: EXPERIENCE FROM A SINGLE-INSURER HEALTHCARE SYSTEM IN POLAND

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Introduction: Compliance of patients with obstructive sleep apnea (OSA) with continuous positive airway pressure (CPAP) can be challenging in healthcare systems that, like the Polish one, do not have any provisions for patient follow-up either for CPAP suppliers or sleep physicians. Additionally, little is known how factors related to device delivery and reimbursement may affect compliance in such systems.

Methods: We conducted a retrospective analysis in 153 consecutive patients diagnosed with OSA, to whom CPAP was recommended based on a CPAP titration study. A structured questionnaire, assessing patients' knowledge of OSA and CPAP, logistics involving obtaining the device, and financial assistance from the national insurer was mailed to all patients. After a month, non-responders were contacted over the phone.

Results: Fifty-eight patients (47M, 11F, 38% of the initial group) responded to inquiry. Their median (IQR) age, apnea-hypopnea index and daytime sleepiness (Epworth Sleepiness Scale) were 61 (56-66) years, 23.3 (11.8-48.7)/h, and 12 (8-13.5) points, respectively, and were not statistically different of the same parameters of non-responders. Forty-two patients (72.4%) purchased a CPAP unit, which was most commonly delivered to their home with a \$300-\$600 copayment. Lack of recognition of OSA as a significant health problem, poor expectation of patient's own ability to get used to CPAP, and high price were the three most common reasons of not obtaining a CPAP unit. Thirty-three patients (56.9%) were using CPAP after a month. Most common reasons for stopping using the device were inability to fall asleep with a mask and upper airway dryness.

Conclusion: Lack of education about OSA and CPAP, and financial restrictions prevented the patients from obtaining the needed therapy for OSA. Factors that could readily be addressed by a trained CPAP supplier or a formal sleep clinic were the most common reasons for CPAP abandonment.

0327

AN EQUIVALENCE STUDY COMPARING A NEW LIGHTWEIGHT AUTOPAP DEVICE TO AN ESTABLISHED AUTOPAP DEVICE

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Introduction: Clinicians may be hesitant to prescribe newly developed Auto-PAP (APAP) devices without assurance of their performance, especially given the sophisticated algorithms for detecting respiratory events. This study was designed to demonstrate that performance of a new lightweight APAP device was equivalent to a well-established, commercially available APAP device.

Methods: This study was a prospective, randomized, double-blind, 2 × 2 crossover trial to determine if the Transcend Auto (N-APAP, Somnedics International) was equivalent in performance to REMstar® Auto C-Flex™, a predicate device (P-APAP, Philips Respironics). Patients previously diagnosed with obstructive sleep apnea (OSA; apnea hypopnea index (AHI) > 15/hr), age > 18 years, and compliant with current CPAP/APAP therapy were included in the trial. Patients underwent two full-night polysomnograms (PSG) with treatment arms counterbalanced. Minimum pressures were set to the same value for each device based upon home use with maximum pressure set at 20 cm H₂O. All PSGs were scored by a central lab blind to the treatment arm.

Results: Among the 35 completed subjects, mean PSG AHI was 2.1 for the N-APAP arm and 2.0 for the P-APAP arm. The test for non-inferiority was significant ($p < 0.0001$), indicating comparable device efficacy. The N-APAP arm also attained a significantly lower average pressure than the P-APAP arm ($p < 0.01$). Other respiratory PSG measures, such as Respiratory Disturbance Index and Respiratory Event Related Arousal index were not significantly different between the devices. There were no clinically significant differences between device-reported AHI and PSG scored AHI. On average, the P-APAP and N-APAP devices overestimated AHI by 0.9 and 0.7 events/hr, respectively.

Conclusion: The N-APAP arm achieved an equivalent benefit for treatment of OSA at a lower average therapy pressure compared to the predicate device. The results conclude that clinicians can confidently use the N-APAP device as an effective therapy option for patients with OSA.

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0328

THE EFFECT OF CPAP TREATMENT ON ATTENTIONAL NETWORKS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Patients with obstructive sleep apnea (OSA) may have impaired cognitive functions. Continuous positive airway pressure (CPAP) appears to improve the cognitive function after a long term of treatment. The task of attentional networks that we used reflects three components with the association of cognitive functions (alerting, orienting and executive control). We assessed the immediate effect of first night to receive CPAP treatment on the task of attentional networks.

Methods: Patients with OSA (42.7 ± 8.5 year old, 50 males, AHI 61.8 ± 22.7/h) were used in the study. After a full night polysomnography (PSG) for diagnosis, the patients received a full night of CPAP pressure titration. The Epworth sleepiness scale (ESS) was evaluated before PSG. The multiple sleep latency tests (MSLT) and the attention network test (ANT) were carried out prior to and following after CPAP titration. We used a version of the ANT by E-prime software. The test consisted of 24 training trials with feedback and 3 experimental blocks without feedback, and each experimental block consisted of 96 trials.

Results: Following CPAP treatment night, the improvements were obtained in all three components of mean reaction time, alerting and executive control, compared with before treatment. According to scores on ESS and MSLT before CPAP treatment, the patients were divided into two groups, excessive daytime sleepiness (EDS) group (ESS > 10 and MSLT ≤ 8) and no EDS group (ESS ≤ 10 and MSLT > 8). No significantly different AHI was found between EDS ($n = 15$, AHI 69.5 ± 17.3/h) and no EDS groups ($n = 15$, AHI 57.7 ± 27.7/h, $p > 0.05$). Between the groups of EDS and no EDS, no difference was found in the three networks at before CPAP treatment. After CPAP treatment compared with before treatment, EDS group showed improvements in alerting and

orienting, no EDS group had improvement in executive control alone ($p = 0.005$). Within the two groups, EDS group showed greater improvements than no EDS group in alerting ($p = 0.01$) and orienting ($p = 0.008$) after CPAP treatment.

Conclusion: The results suggest that CPAP treatment has significant improvement effects on ANT reflected cognitive function evaluation for patients with OSA, particularly for EDS patients with OSA.

0329

PREDICTORS OF CPAP USE AMONG AFRICAN AMERICANS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Evidence from large studies suggests that African Americans with obstructive sleep apnea (OSA) have significantly lower rates of adherence to continuous positive airway pressure (CPAP) compared to Caucasians. In this pilot study, we sought to identify predictors of CPAP adherence among African Americans.

Methods: African American OSA patients previously initiated on CPAP were recruited from the community and divided into active and non-active users based on compliance data. A questionnaire battery including the Self Efficacy Measure of Sleep Apnea (SEMSA), Medical Outcomes Study social support survey, Rapid Estimate of Adult Literacy in Medicine, Beck's Depression Inventory, Functional Outcomes of Sleep Questionnaire (FOSQ), and Epworth Sleepiness Scale were administered. T-tests were used to compare means responses between groups and Cohen's d was used to assess effect sizes.

Results: Thus far, thirteen African American subjects have completed the study. Eight are active CPAP users and five are not actively using CPAP. Mean (± standard deviation) age is 52.9 ± 6.1 yrs, mean body mass index is 38.8 ± 11.4 kg/m², 30.7% are male, and the mean AHI is 32.0 ± 17.0 events/hr. There were no statistically significant differences between active and non-active CPAP users. Based on the SEMSA, risk perception ($d = 0.19$, $p = 0.72$) and outcome expectations ($d = 0.09$, $p = 0.88$) did not differ between active and non-active CPAP users. In contrast, a trend was observed for greater self-efficacy among active CPAP users compared with non-active ($d = 1.33$, $p = 0.07$). No statistically significant differences were detected in measures of social support, health literacy, depressive symptoms, FOSQ, or sleepiness.

Conclusion: Among African Americans with OSA, self-efficacy appeared to be positively associated with adherence to CPAP. The effect size of this relationship was large, suggesting clinical relevance. Interventions targeting self-efficacy may have a role in improving CPAP adherence among African Americans.

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0330

AN IN-HOUSE DURABLE MEDICAL EQUIPMENT PROVIDER IMPROVES TREATMENT OF OBSTRUCTIVE SLEEP APNEA SYNDROME IN MILITARY VETERANS

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Introduction: Nationally, about 50% of US military veterans have acceptable adherence with positive airway pressure (PAP) as treatment for obstructive sleep apnea (OSA). Early experiences, effective troubleshooting, and timely support significantly impact long-term adherence. Physician and patient access to the durable medical equipment (DME) provider is therefore of great importance. At the Veterans' Affairs Con-

necicut Healthcare (VACH) hospital we recently switched from an external DME provider (located 50.3 miles from the main hospital) to a DME provider located within our hospital, and determined how this affected adherence and effective treatment.

Methods: We evaluated data from 217 OSA patients: 131 consecutive PAP machine downloads in 2012 (external DME) and 86 consecutive downloads in 2013 (in-house DME). Acceptable adherence was defined as more than four hours of device use on more than 70% of nights. Acceptable efficacy was defined as a residual apnea-hypopnea index of less than five per hour on PAP. We used the Chi-square test to examine the differences in adherence and efficacy between 2012 and 2013.

Results: There was a trend towards increased adherence from 45.8% in 2012 to 53.5% in 2013, but this was not statistically significant ($p = 0.27$). There was an increase in effective treatment from 48.9% in 2012 to 68.6% in 2013 ($p = 0.004$). In 2012, 25.2% had both acceptable adherence and efficacy, whereas in 2013, this increased to 44.2% ($p = 0.004$).

Conclusion: Our data shows that having an in-house DME provider located in the facility where patients obtain the remainder of their healthcare can increase effective treatment of sleep apnea. Although our study highlights potential advantages to having an in-house DME provider, it also reveals that overall adherence and efficacy, although improved, were still below expectation. Future research will focus on which aspects of the in-house DME resulted in the improved outcome, and what measures can be taken to further improve treatment.

0331

DIFFERENTIAL EFFECTS OF CONTINUOUS POSITIVE PRESSURE AIRWAY TREATMENT ON COGNITIVE FUNCTION AND ARTERIAL STIFFNESS IN THE ELDERLY WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) in elderly population increases the risk of cardiovascular diseases and decreases the cognitive function. However, it is not well known whether these deleterious changes can be reversed by continuous positive airway pressure (CPAP) treatment. Therefore, we aimed to elucidate the effect of CPAP on cognitive function and arterial stiffness in the elderly with OSA.

Methods: Forty two patients (≥ 60 yrs) with moderate-to-severe OSA were enrolled, and then divided into CPAP treatment ($n = 28$) and non-CPAP control groups ($n = 14$). We performed baseline measurements of arterial stiffness and cognitive function. Tests of arterial stiffness comprised pulse wave velocity, central blood pressures and intima-media thickness, and we applied the Korean version of the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) Neuropsychological Assessment Battery for the cognitive function. After about 6 months (175.6 ± 93.3 days), the second measurements of arterial stiffness and cognitive function were completed.

Results: The CPAP group were younger than the control group (65.1 ± 4.5 vs 69.7 ± 5.3 yrs; $P = 0.005$) and had longer duration of education (14.8 ± 4.0 vs 11.2 ± 5.5 yrs; $P = 0.020$). None of arterial stiffness-related variables changed after CPAP treatments. Among the cognitive function tests, the color word task in the Stroop test revealed a significant improvement after CPAP treatment after adjusting the age and the education (35.5 ± 2.0 vs 39.6 ± 1.7 ; $P = 0.023$).

Conclusion: Short-term CPAP treatment could improve executive function, but might not be effective in decreasing arterial stiffness in the elderly with OSA. It needs to be decided whether long-term CPAP use can have beneficial effects on cognitive dysfunctions and cardiovascular risks in elderly OSA.

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0332

WILLINGNESS TO USE POSITIVE AIRWAY PRESSURE FOLLOWING AMBULATORY TITRATION IS NOT CORRELATED TO LONG TERM OBJECTIVE COMPLIANCE

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Introduction: Despite technological advances in positive airway pressure (PAP) devices, patient adherence to therapy remains suboptimal, making clinical prediction of future compliance of value. Our objective was to determine whether long-term electronically-determined mean daily PAP use (MDPU) could be predicted by patient responses on a post-titration questionnaire. A secondary objective was to determine if data obtained on a Type III cardiopulmonary sleep study or demographic data were associated with willingness to use PAP or MDPU.

Methods: The cohort comprised subjects with OSA who underwent ambulatory multi-day automatic-PAP titration (APT), followed by initiation of long-term PAP therapy. Those with mean daily PAP use of < 4 h during APT were excluded. Inclusion criteria included availability of ≥ 3 months of electronic compliance data. 38 subjects (89% male) met eligibility criteria. Mean ESS was 11 (3-22), mean AHI 16.23 (5.5-36.6), mean days of APAP titration 4.4 (3-12), mean AHI on titration was 3.3 (0.4-11.4). Following APT, subjects completed a 10-point scale regarding willingness to use PAP (WTUP), with higher values indicating more willingness to use. Subjects also answered questions regarding feeling restored on awakening (FROA), and subjective symptoms of daytime fatigue (SSDF) following PAP use. Clinical data abstracted included patient age, gender, BMI, Epworth score (ESS), supine, non-supine and total AHIs, days needed for APAP titration, oxygen saturation (SaO_2) nadir, and percent time spent below 90% saturation. Data were analyzed statistically to determine correlations with MDPU.

Results: MDPU was 6.7 ± 1.3 hours. WTUP scores were ≥ 9 in 84% of the cohort, and were statistically uncorrelated with MDPU. Presence of FROA (82%) and SSDF (47%) also showed no correlation to MDPU. SaO_2 nadir showed weak correlation with WTUP scores ($r = -0.33$, $P = 0.05$).

Conclusion: Patient willingness to use PAP following short term APT is uncorrelated with long term adherence to therapy.

0333

CPAP COMPLIANCE ≥ 4 HOURS PER NIGHT IN THE CPAP UTILIZATION DEVELOPMENT FROM DIRECTED LEARNING, EDUCATION AND SUPERVISION (CUDDLES) STUDY

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Introduction: Continuous positive airway pressure (CPAP) is an effective treatment for obstructive sleep apnea (OSA). However, patient compliance with CPAP ranges widely (23-80%) in context of the current broadly used standard of ≥ 4 hours CPAP use per night. The CUDDLES Study sought to investigate the effects of patient education and ongoing communications with email as the communication medium in an effort to improve CPAP use.

Methods: OSA patients prescribed with CPAP were prospectively randomized to a control or intervention group. Both groups received an initial education email. The intervention group received five additional unique emails at bi-weekly intervals over the initial 90 day period of CPAP use. These emails included information about their OSA severity and encouragement in CPAP use. The emails also included embedded links to additional information on using CPAP and on the health benefits of CPAP use. Both the intervention and control group were called after Day 90 for a follow-up survey. Objective CPAP usage data was also collected from the device after 90 days.

Results: Compliance data was collected on 125 patients, 57 in the control group and 68 in the intervention group. There were no statistical differences between the groups in baseline demographics (age, BMI, severity of OSA, gender, Epworth Sleepiness Score, STOP-Bang score or ethnicity). Analysis showed a statistically significant difference in percent of days with use of CPAP ≥ 4 hours between the intervention group (77.5%) and the control group (62.3%) [$p = 0.004$].

Conclusion: This study demonstrates a positive impact on CPAP usage from regular, scheduled encouragement and patient education using email as the engagement tool during the initial 90 days of CPAP use.

0334

CPAP USAGE PATTERNS IN A CONSECUTIVE SERIES OF PATIENTS DURING AND AFTER PHYSICIAN-LED ACCLIMATISATION PROGRAM

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Introduction: Intensive support in early continuous positive airway pressure (CPAP) acclimatisation may improve subsequent usage. We reviewed CPAP usage patterns of a consecutive patient series presenting to a tertiary hospital sleep clinic for structured physician-led acclimatisation program.

Methods: CPAP usage patterns were collected prospectively into a registry during the process of acclimatisation at the Canberra Hospital. A retrospective chart review was carried out to assess whether this cohort of patients attended scheduled clinic appointments and whether they continued with CPAP therapy.

Results: 169 patients were entered into the Canberra Hospital PAP Acclimatisation Registry over a 12-month period. The mean age is 55.2 ± 13.7 years with median BMI 32.5 kg/m^2 (IQR 27.9-39.7). Most had moderate to severe obstructive sleep apnea (median AHI 33.6/hr, IQR 17.4-57.7). All patients attended fortnightly clinics delivered by sleep physician and scientist/nurse to assess usage and troubleshoot CPAP therapy after commencement. 122/169 (72%) expressed desire to pursue long term therapy and this group has demonstrated higher CPAP usage. 99/169 (58%) attended sleep clinic after acclimatisation of which 85 pursued long term CPAP use. 77 are still using CPAP at time of clinic visit whilst 8 have discontinued CPAP. Patients who continued to use CPAP demonstrated increasing usage per night during the acclimatisation visits (295 to 333 minutes/night) while those who subsequently stopped CPAP after acclimatisation have decreasing usage (210 to 188 minutes/night). The group remaining on CPAP maintained mean usage of 330 minutes/night by the time of clinic visit.

Conclusion: Early CPAP usage pattern appears to determine long term CPAP usage. Decreasing CPAP usage during acclimatisation is associated with subsequent CPAP discontinuation at follow-up. Interventions to increase early CPAP usage may improve long term CPAP usage.

Support (If Any): Canberra Hospital Foundation for set up for registry.

0335

THE EFFECTS OF IMPLEMENTATION OF POST CARE CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) PROGRAM UPON PATIENTS' COMPLIANCE ON CPAP

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Introduction: We addressed patients' compliance on CPAP by implementation of post care CPAP program, which consists of the following: nasal mask fitting, face to face patient visit with physician to address issues that improve compliance and review the raw data of sleep testing using the sleep software and at least one phone call to patient either by physician or a trained RPSGT. In this cross sectional, retrospective chart review project, we examined the effects of the post care CPAP program on patients' CPAP compliance.

Methods: We randomly reviewed and examined 159 adult patients' charts from January 2013 to end of July 2013. The following parameters were evaluated: respiratory parameters of the PSG, compliance percentage for CPAP use for > 4 hours a night between 30 and 90 days from initiation of CPAP, any co-morbid medical conditions, numbers of follow up visits after initial consults, and numbers of documented phone conversations with patients.

Results: A) Our random sample consisted of 68% males with mean age 59.2 years and AHI 35.7 events/hr. The remaining were females with mean age 57.4 years and AHI 27.8 events/hr. B) The utilization of post care CPAP program shows a compliance rate of 80% as per Medicare guidelines. Total number of patient's compliance increased substantially to Medicare satisfaction by the third patient's encounter. There is no correlation between increased numbers of patients' encounters of more than 3 times upon compliance on CPAP. C) Healthy patients with no co-morbid illness achieve Medicare compliance better than patients with one or more co-morbid illness. There is no correlation between number of co-morbid illnesses and compliance on CPAP.

Conclusion: The utilization of a structured post care CPAP program improves patients' compliance.

0336

PATIENTS' SUBJECTIVE MEASURES PREDICTING CPAP COMPLIANCE

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Introduction: This study assessed two possible predictors of CPAP compliance: Self reports of nightly sleep duration before CPAP therapy and subjective experience of sleep quality following the initial CPAP titration.

Methods: This retrospective study viewed medical charts of patients with newly diagnosed sleep apnea followed by an in lab CPAP titration between January 2010 and December 2012 in MVH-Clyo sleep center, Dayton, Ohio. Variables assessed included self reports of nightly sleep duration in the two weeks prior to consultation from the Epworth Sleepiness Scale, and subjective experience of sleep quality surveyed the morning after CPAP titration by the choice of three answers to the question: "How did you feel upon awakening?" Choices presented were "more rested than usual," "less rested than usual," or "about the same." The definition of compliance was a minimum of four hours per day over 70% of days from CPAP initiated to the first follow up visit (up to 100 days).

Results: A total of 375 patients' data as independent predictors (e.g., gender, age, BMI, ESS, habitual sleep duration, and subjective experience of sleep quality) were analyzed. Stepwise linear regression modeling demonstrated that there was only one predictor, habitual sleep

duration, was associated with CPAP compliance ($72.4 \pm 27.4\%$, $p < 0.001$). We also found that a short sleep duration (less than 6 hours) had the risk of noncompliance. However, the subjective experience of sleep quality surveyed (45.2% of more rested, 13.1% of less rested and 41.7% of the same) did not differ between compliance and non-compliance.

Conclusion: Patients' reports of habitual sleep duration less than six hours may be a predictor of future CPAP noncompliance. Patient reports of sleep quality immediately after their initial CPAP night may not be a useful predictor of future treatment adaptation.

0337

CPAP COMPLIANCE IN MALE INSOMNIA PATIENTS WITH OSA

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Introduction: OSA is more common in male patients, and male insomniacs showed high prevalence of OSA. But they have poor subjective quality of sleep and sensitive to external stimuli. It is often very difficult to persuade insomnia patients with OSA to wear CPAP.

Methods: Male insomnia patients who underwent PSG at Seoul Sleep Clinic for 2 years, from 2010 to 2011, were reviewed for OSA and CPAP usage, evaluated through chart review.

Results: 52 out of total 116 PSG data have OSA (AHI > 5). Insomnia/OSA patients comprised of 44.8% of total insomnia patients who had done PSG in males. 32 had at least moderate degree of OSA with AHI above 15 per hour. Age above 50 comprised 69.2% of total insomnia/OSA cases. All insomnia/OSA patients were recommended to use CPAP initially. 7 out of 53 OSA patients succeeded in wearing CPAP for at least 1 week. Some tried to use CPAP for one or two nights but failed to use it further. Some refused to wear CPAP and left the clinic. Only 5 patients continued to wear CPAP for at least 1 month. 3 were still compliant with CPAP after 1 year.

Conclusion: OSA was prevalent in male insomnia patients especially after age 50. When evaluating aged male insomnia patients, it is important to consider possible OSA diagnosis because many hypnotics have bad effect on OSA symptoms. However, CPAP compliance in insomnia/OSA is very disappointing. Special management plan for insomnia/OSA patients is needed to manage their sleep difficulties as well as to manage their OSA.

0338

POSTTRAUMATIC STRESS DISORDER AND POSITIVE AIRWAY PRESSURE USE

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Introduction: Posttraumatic stress disorder (PTSD) patients with comorbid sleep-disordered breathing (SDB) may have difficulty using traditional PAP therapy (CPAP, APAP, and BPAP). We hypothesized newer, more-advanced PAP therapy devices (ASV or ABPAP) would improve PTSD patient comfort with and ability to use PAP therapy.

Methods: This retrospective chart review included 113 adult patients [50.4% female, 55.8% Caucasian, 60.2% married, 62.8% some college or less, and mean (SD) BMI = 30.00 (9.25)] seen at Maimonides Sleep Arts & Sciences, Albuquerque, NM. Subjective sleep data were obtained from online intake questionnaires. All eligible patients scored > 21 on the Posttraumatic Symptom Severity Scale (PSS) [mean (SD) score = 29.50 (7.15) (consistent with moderate to severe PSS)], completed ti-

tration PSGs, and were prescribed PAP therapy. Current PAP use was determined from subjective or objective evidence obtained during most-recent follow-up.

Results: Two groups were contrasted based on PAP use: Users ($n = 94$) and Non-Users ($n = 19$) with no difference in PSS scores. At intake, a significantly higher proportion of Users reported classic SDB symptoms compared to Non-Users: snoring (84.0% vs 57.9%; $p = .02$); disruptive snoring (45.7% vs 15.8%; $p = .01$); choking/gasping/struggling for breath (64.9% vs 31.6%; $p = .01$); and witnessed apneas (66.0% vs 42.1%; $p = .05$). Patient identification of SDB as a sleep problem trended higher among Users (67% vs 47.4%; $p = .09$). Ranking SDB higher in importance was also associated with greater use ($p = .03$). Of the 94 current PAP users, 50 (53.19%) use ASV and 44 (46.81%) use ABPAP. The vast majority of patients reported greater comfort with advanced pressure modes compared to traditional PAP.

Conclusion: In contrast to conventional wisdom, patients suffering from moderate or worse PTSD symptoms and co-morbid SDB demonstrated a high rate of PAP use (83.19%) when prescribed advanced pressure mode devices suggesting a salient comfort effect. Greater awareness of SDB symptoms was associated with greater PAP use. Randomized control trials should investigate the benefit of advanced versus traditional PAP in PTSD patients with comorbid SDB.

0339

FACTORS ASSOCIATED WITH THE REJECTION OF INITIAL CPAP TRIAL IN PATIENTS NEWLY DIAGNOSED WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Long-term compliance with CPAP is a well-recognized problem in the management of patients with OSA. Less well studied is the issue of patients who reject CPAP upfront, without even trying. In Singapore, this is a major concern and the focus of this study.

Methods: Analysis of consecutive patients who underwent PSG for suspected OSA over a 6 month period in a single tertiary sleep center. Follow-up telephone interview was performed in patients prescribed CPAP one year later.

Results: 529 patients underwent diagnostic polysomnography in the Singapore General Hospital Sleep Disorders Unit from January 2012 to June 2012. 220 patients had an AHI ≥ 15 and of these, 166 patients were symptomatic with an ESS of 10 or more. 43 of these patients rejected CPAP counseling up front. Reasons included: declined CPAP and further follow-up (23/43), pursuing other treatment options for OSA (12/43), lost to follow-up (3/43) or other reasons (5/43). A further 31 patients rejected a trial of CPAP after the counseling session. Reasons given by patients for rejecting CPAP trial included: did not see the need for treatment (6/31), found CPAP troublesome (10/31), too costly (7/31) or pursuing alternative therapy such as surgery, dental appliances or bariatric surgery (4/31).

Conclusion: Despite the improving availability of diagnostic and treatment services for OSA in Singapore, uptake of PAP therapy remains very poor and many patients with symptomatic and moderate to severe OSA end up without treatment. Of 166 symptomatic patients diagnosed with significant OSA, 74 patients rejected a trial of CPAP, and most end up without therapy. Poor disease awareness, ignorance about the importance and effectiveness of PAP treatment and high financial costs are some of the contributing factors which should be addressed to improve the uptake of CPAP in OSA patients.

0340

CAN A DECREASE IN BLOOD PRESSURE SERVE AS A MARKER OF PAP COMPLIANCE?

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Introduction: The contribution of OSAS in the development of systemic hypertension has been well established over the past two decades. Even though it seems reasonable to assume that PAP treatment will have a beneficial effect on blood pressure, study results were inconclusive. We hypothesized that in our sleep medicine clinic, the patients diagnosed with hypertension, who use their PAP device, will have lower blood pressure at their follow up visits and therefore, the reduced blood pressure can serve as a marker for PAP use.

Methods: This is a retrospective database review. Included in the analysis were data points for consecutive patients over a period of two years. Inclusion criteria were: previous diagnosis of high blood pressure on stable treatment, initial sleep medicine evaluation, at least one return visit and self-reported compliance with PAP treatment. A t-test analysis was performed.

Results: 23 (13 males) patients were included in the analysis. By age, most of the patients, (78%), were in their 40's and 50's with 5 outliers (3 in late 20's and 30's and 2 in their 60's). Approximately two thirds, 15 patients (65%), were obese (BMI of 30 or higher). Initial mean systolic blood pressure was 138.6 ± 17.6 . Initial mean diastolic blood pressure was 84.1 ± 11.4 . At follow up, the mean systolic blood pressure was 129 ± 13.3 ($p < 0.005$) and the mean diastolic blood pressure was 80.5 ± 8.3 ($p < 0.03$).

Conclusion: 1) Adequate PAP compliance is associated with a decrease in blood pressure in patients with systemic hypertension; 2) A decrease in blood pressure could be considered as a marker of adequate PAP use; 3) Limitations: this is a small case series with no group comparison. There is a need for larger, double blind, randomized studies.

0341

FOCUS GROUPS ANALYZING BARRIERS TO CPAP ADHERENCE AMONGST DIFFERENT ETHNIC GROUPS IN NEW ZEALAND

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Introduction: Our group has previously demonstrated that ethnicity is a predictor of CPAP adherence in a New Zealand (NZ) sample. To further elucidate the reasons for the ethnic disparity in CPAP adherence, we aimed to conduct focus groups of newly-diagnosed Māori, Pacific and NZ European patients undergoing CPAP treatment for obstructive sleep apnoea.

Methods: CPAP patients of Māori, Pacific and NZ European ethnicity attended separate, 1.5-hour group discussions facilitated by a healthcare worker of the same ethnic group using an interview template. Thematic analysis was applied to the discussion transcripts independently by two investigators, following published guidelines.

Results: Five Māori, five Pacific, and eight NZ Europeans participated (mean age 47, range 30-71 years, mean \pm standard deviation CPAP adherence 6.32 ± 1.25 hours/night). Patients in all three groups reported that they had minimal prior knowledge of OSA and CPAP. All groups identified barriers to treatment (both at the CPAP initiation phase and long-term), feeling overwhelmed during the initial CPAP education ses-

sion, and the importance of successful role models. Family and friends generally supported CPAP therapy.

Conclusion: The three ethnic groups reported similar initial CPAP experiences, highlighting access barriers to publicly funded assessment/treatment pathways and sleep health knowledge as key issues. Educational resources to improve access, enable self-management and increase community awareness of the importance of healthy sleep may help overcome some of the issues identified in this study.

Support (If Any): New Zealand Ministry of Internal Affairs Lottery Health Research Grant #2676747.

0342

INTERNET-BASED CPAP ADHERENCE VIA THE NET (ICAN) TRIAL

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Introduction: Adherence with continuous positive airway pressure (CPAP) therapy remains less than ideal in patients with obstructive sleep apnea (OSA). Internet-based education and feedback has been effective in management of insomnia. The aims of this pilot project were to see if the use of internet-based education can improve CPAP adherence and reduce nursing time involved in assisting our CPAP users.

Methods: Participants (CPAP naïve) were randomly assigned to either the usual care (educational materials and nurse's business card) or to usual care plus access to a secure webpage that included additional educational material and encouraged to answer weekly a questionnaire designed to address self-identified troubles. Web group was given the option to email our nurses with questions.

Results: The mean age (25 subjects in each arm) was 53.4 ± 12.6 , BMI of 33.9 ± 6.7 , AHI of 24.4 ± 20.3 , and ESS of 8.9 ± 5.6 . On follow up, 10 subjects in the control arm did not return or return compliance data in spite of phone calls and mail requests, while 2 in the web arm did not start CPAP and 7 did not return. At 30 days, the control subjects' compliance averaged 386 ± 102 minutes over 28 ± 4 days with 79% nights used > 4 hours, while the web arm subjects averaged 304 ± 139 minutes over 24 ± 9.5 days with 63% nights used > 4 hours. Two of the control subjects called our nurses while 6 in the web arm e-mailed. These values were not statistically different. Subject who used the web-based program found the program helpful.

Conclusion: In this pilot project of web-based education program, we did not find improvements in compliance or reduction in need for nursing intervention, although the subjects who used the web-program found it helpful.

Support (If Any): Mayo Clinic Center for Innovation.

0343

DOES THE PRESSURE NEEDED TO RELIEVE OBSTRUCTION UTILIZING A SELF TITRATING CPAP DEVICE DIFFER FOLLOWING ELECTIVE TOTAL JOINT SURGERY?

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Introduction: Many patients with obstructive sleep apnea (OSA) that are treated with continuous positive airway pressure (CPAP) undergo surgery. Factors such as post-operative pain medications, positioning, and REM rebound seem likely to alter CPAP pressure needs post-surgery compared with pre-surgery. This has yet to be systematically studied. In this pilot study we evaluated whether this is the case in order

to determine whether an adjustment in CPAP pressure is needed post-operatively in order to prevent inadequate CPAP therapy.

Methods: 19 elderly patients at risk for OSA (STOP-BANG score > 2) who were not previously using CPAP were placed on auto-titrating CPAP prior to undergoing elective knee and hip replacements. We compared CPAP pressure needs in the days immediately prior to and after surgery.

Results: Subjects used their devices for an average of 4.73 ± 4.0 nights preoperatively and 1.58 ± 0.5 nights postoperatively. Across the group, CPAP pressure needs increased when controlling for baseline pressure ($p = 0.04$). 13/19 patients had an increase in CPAP pressure need post-operatively.

Conclusion: This study provides preliminary evidence that CPAP pressure needs increase postoperatively in many patients. This supports the potential utility of adjusting pressures across the surgical process or using auto-titrating CPAP devices in patients undergoing surgery. Further work is needed to identify patient or operative factors associated with the increase in pressure need.

0344

CPAP USE, WEIGHT CHANGE AND METABOLIC OUTCOMES: DATA FROM 3 RANDOMISED CONTROLLED TRIALS

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Introduction: Recent data has shown that CPAP increases weight in a dose-dependent manner compared to sham CPAP. However it not known whether this weight gain is associated with metabolic dysfunction in a dose-dependent manner.

Methods: Patient-level meta-analysis using the first arm of three randomised sham-controlled trials was performed to test whether patients gained weight in a dose-dependent manner. Metabolic markers (fasting glucose, insulin and insulin resistance [HOMA]) were also tested to indirectly determine whether weight changes might be due to increases in fat mass. Mixed model analysis of variance was used to quantify the effects of CPAP, dose (hours/night), their interaction and regression to the mean.

Results: 82 and 79 participants received CPAP and sham respectively. High use (> 20 hrs/week) was associated with greater weight gain across both treatments (difference 0.96 kg; 95%CI 0.0 to 1.9, $p = 0.04$). CPAP increased weight compare to sham irrespective of dose however the difference did not reach significance (0.83 kg; -0.08 to 1.7, $p = 0.07$). High use of CPAP increased weight more than high use sham (1.4 kg; 0.04 to 2.9, $p = 0.05$) and more than low CPAP use (1.6 kg; 0.4 to 2.8, $p = 0.01$). There was no difference between high and low sham users (0.36 kg; -1.0 to 1.7 NS). Neither treatment alone, CPAP dose alone nor the combined effect of both influenced glucose, insulin or insulin resistance.

Conclusion: High use CPAP increases weight compared to high use sham and low use CPAP without any subsequent changes in metabolic dysfunction. It is possible an increase in lean muscle mass rather than fat is the cause of the weight gain which may not necessarily have a detrimental effect on health.

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0345

POSITIVE AIRWAY PRESSURE ADHERENCE IN ADULT PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND DOWN SYNDROME

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Introduction: Obstructive sleep apnea (OSA) is a significant comorbidity among adult patients with Down Syndrome (DS). Positive airway pressure (PAP) is the standard treatment for OSA; however concerns exist about the ability of these patients to adhere to PAP therapy. Therefore, we sought to better understand PAP adherence patterns in DS adults.

Methods: Observational cohort analysis of DS (ICD-9 758.00) and OSA (ICD-9 327.23) patients from an academic sleep medicine clinic. We describe baseline characteristics and polysomnography findings from chart review and PAP adherence from data obtained from patients' PAP machines. Adherence to PAP was defined as > 4 hours per night for at least 70% of nights.

Results: Of 20 patients with OSA and DS, 85% were male, mean age at diagnosis was 25 (SD 7), mean BMI 31.8 (SD 5.8), 80% had cardiovascular comorbidities, and the mean baseline level of daytime sleepiness (Epworth scale) was 10.5 (SD 5.3). Based on the diagnostic sleep study, the median sleep efficiency was 78.1% (IQR 59.6-84.8), the median AHI was 27.2 (IQR 17.4-59.3), and the mean nadir oxygen saturation was 80.5% (SD 7.9). Nineteen patients had an attended PAP titration study; median sleep efficiency was 76.6% (IQR 60.5-80.2) and mean nadir SpO₂ was 88.7% (SD 5). In 18 patients, median total AHI (at all pressures) was reduced to 1.6 (IQR 0.3-7.9). Average compliance rates were as follows: 0-5 months ($n = 17$), 52% (SD 35); 6-11 months ($n = 18$), 61% (SD 34.5); 12-23 months ($n = 14$), 60% (SD 28.7); and > 24 months (10 subjects), 53% (SD 31.8). At 12 months, 35% achieved > 4 hours of adherence for 70% nights and 55% achieved > 4 hours for 50% nights. 2 patients were treated with alternative therapies.

Conclusion: Adult patients with OSA and DS can achieve acceptable sleep efficiency during attended studies and are reasonably adherent to PAP therapy.

0346

BOTH RELATIONSHIP STATUS AND RELATIONSHIP QUALITY ARE PROSPECTIVELY ASSOCIATED WITH CPAP ADHERENCE

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Introduction: Untreated obstructive sleep apnea (OSA) can negatively impact relationship quality. It is unclear to what extent relationships influence CPAP adherence and the few available studies have almost exclusively focused on married men.

Methods: 253 patients with OSA who were participating in a CPAP adherence intervention trial were included in analyses (39% female). All subjects were new to CPAP. Relationship status at baseline was categorized as coupled (married, living with a partner) versus single (never married, divorced/separated, widowed). Family relationship quality was assessed at baseline by the 12-item General Functioning subscale of the Family Assessment Device. Questions address aspects of family relationships such as the extent to which family members express feelings with each other, feel accepted by each other, and confide in each other. A

higher score indicates worse relationship quality. Adherence was measured objectively, and was defined as average hours of CPAP use per night during a 3 month follow-up period. A simultaneous multiple linear regression model examined the prospective association of relationship status and relationship quality with CPAP adherence while adjusting for age, gender, randomization assignment (motivational enhancement, education only, or standard care), body mass index, apnea-hypopnea index, and daytime sleepiness.

Results: Individuals who were coupled had better CPAP adherence at 3 months than individuals who were single ($\beta = 0.17$, $p < 0.01$). In addition, higher relationship quality was associated with better adherence ($\beta = -0.13$, $p < 0.05$). Age was the only covariate that predicted adherence. Older age was associated with greater adherence at 3 months ($\beta = 0.21$, $p < 0.01$).

Conclusion: These findings suggest that patients who are single or who have unsupportive family relationships are at risk for worse CPAP adherence. CPAP adherence interventions may benefit from targeting individuals who are single and/or individuals who have less family support.

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0347

MONITORING CEREBRAL HEMODYNAMICS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME DURING CONTINUOUS POSITIVE AIRWAYS PRESSURE THERAPY WITH NEAR-INFRARED SPECTROSCOPY

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Introduction: Obstructive sleep apnea syndrome (OSA) can lead to increased cardiovascular risk including stroke due to the impairment in cerebral vascular autoregulation. Continuous positive airways pressure (CPAP) therapy at night is the most effective treatment for OSA. However, there is no suitable bedside monitoring method evaluating the treatment efficacy of CPAP therapy, especially to monitor the recovery of cerebral hemodynamics. Near-infrared spectroscopy (NIRS) is ideally suited for non-invasive monitoring the cerebral hemodynamics bedside, providing a promising tool to assess dynamic changes of cerebral hemodynamics during CPAP therapy.

Methods: 7 patients with OSA were measured. One-hour baseline measurements were conducted without CPAP machine after falling asleep with video-polysomnography and NIRS monitoring. After that patients accepted CPAP therapy (S9 AutoSet™, ResMed, Australia) and slept for the whole night. Fragments of NIRS measurements that were at least 20-min long and without motion artifacts were chosen. The amplitudes and power spectral densities (PSDs) of these fragments corresponding to baseline and different CPAP pressures measurements were calculated and compared (Sign test, $p < 0.05$).

Results: We found periodic oscillations in HbO₂, HHb, tissue oxygenation index and blood volume associated with periodic apnea events during baseline measurements. The amplitudes of these oscillations were gradually attenuated and finally eliminated with the stepwise increments of CPAP pressures. The oscillations were totally eliminated in blood volume earlier than in other hemodynamic parameters. A shift in the PSDs of NIRS measurements to lower frequencies with increasing CPAP pressures was observed, suggesting apnea changes to hypopnea.

Conclusion: The dynamic of the restorations of OSA induced cerebral hemodynamic oscillations during CPAP therapy can be assessed by NIRS. Blood supply recovered first during CPAP therapy, followed by the recovery of oxygen consumption. NIRS is a useful tool to evaluate the efficacy of CPAP therapy bedside and in real time.

Support (If Any): This work was supported by Scientific Foundation of Clinic Barmelweid.

0348

DEVELOPMENT OF THE USE-SA QUESTIONNAIRE FOR MEASURING PATIENT-REPORTED RATINGS OF POSITIVE AIRWAY PRESSURE EQUIPMENT USABILITY

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Introduction: A growing number of positive airway pressure (PAP) device users are older and have physical/sensory impairments such as arthritis. For these individuals, the usability of their PAP devices (e.g., efficiency, satisfaction) may impact the frequency and safety of device usage. Instruments to conduct population-level surveys of PAP usability (as opposed to direct observation) have not been available. In this study, we developed the Usability of Sleep Apnea Equipment (USE-SA) questionnaire to measure patient-reported usability of PAP devices.

Methods: Multistage questionnaire development included in-depth interviews to identify relevant content areas, a technical panel to assess content validity of items, cognitive interviews to refine items, and a cross-sectional survey of Veterans Affairs sleep clinic patients ($n = 100$). We conducted a confirmatory factor analysis to evaluate the hypothesized factor structure of the items. We evaluated the model's fit to the data, estimated each scale's internal consistency reliability, and examined score distributions for each scale/item.

Results: Sixty-seven percent of the sample was age ≥ 60 years. The questionnaire consisted of 13 items with a 5-point response format measuring 7 factors: 1) overall ease of use [3 items; $\alpha = 0.81$], 2) ease of cleaning [1 item], 3) ease of knowing if equipment is working properly [1 item], 4) overall satisfaction [1 item], and ease of use/satisfaction with parts--5) interface [2 items; $\alpha = 0.78$], 6) tubing/humidifier [2 items; $\alpha = .79$], and 7) device controls [3 items; $\alpha = 0.94$]. The comparative fit index for the model was 0.96, indicating good model fit. Mean scale/item scores ranged from 64 [SD 33] to 88 [SD 20] on a 0 to 100 possible range.

Conclusion: This study provides initial support for the USE-SA for measuring the usability of PAP devices in sleep clinic patients. Larger studies to obtain patients' ratings of usability of their PAP devices are needed.

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0349

CPAP COMPLIANCE: EFFECTS OF CPAP ADAPTATION PERIODS, OSA SEVERITY AND OTHER PARAMETERS ON CPAP COMPLIANCE

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Introduction: Although the most effective treatment option for obstructive sleep apnea (OSA) is continuous positive airway pressure (CPAP), a significant proportion of patients are unable to adhere and comply with its consistent use. The objective of this study is to explore the various parameters and conditions that the patients experience before the initiation of CPAP treatment that may help to predict and influence the likelihood of longer term CPAP compliance.

Methods: A retrospective, chart review and survey study was performed; analyzing the CPAP compliance of long term (4-6 months) post CPAP titration and fitting, on a total of 97 patients diagnosed with moderate to very severe OSA. The effects and predictability that OSA severity, Epworth scores, CPAP trial duration prior to titration, sleep efficiency during titration and any co-morbidities prior to treatment have on future CPAP use were analyzed.

Results: A significant proportion of CPAP compliant patients had very severe OSA (AHI > 45), while the majority of non-compliant patients had moderate OSA ($p < 0.04$). Additionally, patients in the severe OSA groups had the highest individual percentage use of CPAP, relative to moderate OSA patients ($p < 0.02$). This study also confirms that an optimal CPAP trial of 7 to 14 days prior to titration is associated with the strongest compliance, relative to shorter and longer CPAP adaptation periods ($p < 0.04$). Finally, results indicated that CPAP compliance was not influenced by pre-existing excessive daytime sleepiness, cardiovascular co-morbidities, nor sleep efficiency during night of titration.

Conclusion: This study confirms the general understanding that the severity of OSA influences the outcome of CPAP compliance. Patients with more severe OSA are more likely to adhere to long term use of CPAP. Furthermore, the duration of pre-CPAP treatment adaptation plays a significant role in determining compliance, with the average 7 to 14 days being an optimal period. The degree of cardiovascular co-morbidities did not influence the patient's decision to the use of CPAP, indicating that more patient's education on relationship between cardiovascular diseases and OSA is needed to further increase compliance. The presence of significant sleepiness before treatment did not enhance the subsequent CPAP use, suggesting the possibility that CPAP may not have a sufficiently positive impact on sleepiness as expected and therefore did not lead to long term adherence and use. A good and completed CPAP titration study resulting from efficient sleep also did not seem to facilitate long term CPAP use in this study.

0350

IMPACT OF THE PAP-NAP ON PAP ADHERENCE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA: THE CLEVELAND CLINIC EXPERIENCE

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Introduction: The PAP-Nap is an abbreviated daytime cardio-respiratory study for patients with rejection/hesitancy or intolerance to, or co-morbid conditions impairing acceptance of PAP therapy. We analyzed PAP adherence after PAP-Naps in patients with obstructive sleep apnea (OSA).

Methods: A retrospective analysis of OSA patients who underwent PAP-Naps from August 2012 to November 2013 was performed. The procedure is a one-on-one PAP desensitization with a sleep technician, followed by in-lab recording of snoring, airflow, respiratory effort, oxygen saturation, heart rate, body position and leak. Clinical and polysomnographic data and PAP adherence within 90 days post PAP-Nap were obtained by electronic medical record review. Adherence was classified as PAP use ≥ 4 hrs $\geq 70\%$ of nights and any level of use. In patients without objective adherence data, self-reported data collected electronically by the Cleveland Clinic Neurological Institute's Knowledge Program were used.

Results: Baseline characteristics of 62 patients include mean age 56.2 ± 16.7 yr, BMI 32.7 ± 10.6 kg/m², AHI 42.0 ± 30.6 , and 54.8% female. PAP-Nap indications included anxiety/claustrophobia (53%), PAP rejection/hesitancy (32%) and/or PAP intolerance (68%). Those reporting the PAP-Nap as successful and indicated intent to use PAP in the future numbered 58 (93.5%). Follow-up data were available in 50 (80.7%) patients. No difference in baseline characteristics was found between patients with and without follow-up. PAP adherence was documented in 46 (74.2%) patients including objectively in 58.7%. Of these, 11 (22.0%) used PAP ≥ 4 hrs $\geq 70\%$ of nights, and 38 (76.0%) were using PAP at any level at follow-up. No relationship was found between adherence and PAP use prior to PAP-Nap.

Conclusion: The PAP-Nap salvaged the majority of patients who otherwise would have rejected therapy, although a minority achieved stan-

dardly accepted levels of use. Further work is required to determine the long-term impact of PAP-Naps on PAP failure OSA patients.

0351

DOES POSITIVE AIRWAY PRESSURE THERAPY REDUCE THE INCIDENCE OF POSTOPERATIVE DELIRIUM IN PATIENTS AT RISK FOR OBSTRUCTIVE SLEEP APNEA? INTERIM ANALYSIS RESULTS FROM A RANDOMIZED CONTROLLED CLINICAL TRIAL

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Introduction: Postoperative delirium is a common condition associated with high morbidity, increased length of stay, and a high rate of institutionalization after discharge. Previous work has established an association between obstructive sleep apnea (OSA) and the development of postoperative delirium, but it remains unclear whether this risk factor is modifiable in the perioperative setting.

Methods: Patients at risk for OSA, defined by a STOP-BANG score > 2 , who were untreated for OSA and scheduled to undergo elective joint replacement were prospectively enrolled. Subjects were randomized to receive continuous positive airway pressure (CPAP) or routine perioperative care. CPAP subjects were instructed to wear an autotitrating CPAP device prior to surgery and on postoperative days 0, 1, and 2. Delirium was assessed postoperatively using the Confusion Assessment Method and the continuous Delirium Rating Scale-R-98. Apnea-Hypopnea Indices (AHI) were collected from the subjects that used CPAP.

Results: 66 subjects have completed the study so far; 34 CPAP subjects and 32 routine care subjects. CPAP subjects used their devices for an average of 3.44 ± 3.7 nights preoperatively (mean use 2.90 ± 2.4 hours/night) and 1.00 ± 0.9 nights postoperatively (mean use 3.00 ± 3.3 hours/night). Ten subjects (15.1%) experienced delirium; five (14.7%) received CPAP and five (15.6%) did not. Delirious subjects were older (mean age 70.1 versus 62.5, $p = 0.013$) but had identical pre-operative STOP-BANG scores (4.4). However, amongst the CPAP subjects, the degree of preoperative AHI predicted 24% of the delirium severity in the continuous model ($F = 4.76$, $p = .045$).

Conclusion: This interim analysis preliminarily suggests that perioperative CPAP neither increases nor decreases the risk of postoperative delirium in patients at risk for obstructive sleep apnea. If corroborated in the complete study this would suggest that the increased delirium risk of OSA is not mediated by acute effects of the condition or may not be modifiable.

0352

CPAP USE IMPROVES SEXUAL FUNCTION IN MEN WITH OSA AND ERECTILE DYSFUNCTION: A RANDOMISED CONTROLLED STUDY

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Introduction: Erectile dysfunction (ED) is common in OSA. Uncontrolled studies suggest CPAP improves ED and PDE-5 inhibitor treatment for ED may worsen OSA however no randomised controlled studies exist. This study investigated the effects of CPAP and a low daily dose of a PDE-5 inhibitor on sexual function.

Methods: 61 men with OSA (AHI > 20) and ED were randomised to 12 weeks of CPAP or Sham CPAP as well as 10 mg daily Vardenafil or placebo in a factorial design study. Sexual function was assessed using International Index of Erectile Function (IIEF), Self-Esteem & Relationship Scale, European Male Aging Study and Erectile Dysfunction Inventory of Treatment Satisfaction questionnaires. Sleep related erections (SRE's, subset of n = 35) were assessed using Rigiscan. Quality of life was also assessed. A sub-analysis in participants who used CPAP or Sham more than 4 hours per night was also performed (n = 20).

Results: 55 men completed the trial. Overall, CPAP did not improve ED. However, participants adherent to CPAP trended toward an improvement in ED (p = 0.08), which was clinically relevant (Δ IIEF-ED > 4 points) compared to those adherent to sham. These participants also improved in the domains of overall sexual satisfaction, confidence, vigilance, physical function, vitality, social function, mental health, depression and stress and were more satisfied with treatment compared to sham (all p < 0.05). The PDE-5 inhibitor improved SRE's and self-esteem and reduced distress due to sexual dysfunction. Participants were more satisfied with PDE-5 inhibitor compared to placebo (p < 0.05) and this did not worsen OSA.

Conclusion: Adherent CPAP use improves sexual function, and several parameters of mental health and quality of life, however, adherence to CPAP was low in this study. Participants who received active medication or were adherent to CPAP were more satisfied with this treatment for erectile function compared to placebo.

Support (If Any): NHMRC Project Grant 632833; NHMRC Scholarship 633166.

0353

AUTOMATIC POSITIVE AIRWAY PRESSURE (APAP) VERSUS MANUAL CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) TITRATION IN PARKINSON'S DISEASE (PD) PATIENTS WITH OBSTRUCTIVE SLEEP APNEA (OSA)

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Introduction: OSA is common in the general population and in PD. The aim of this study was to assess the feasibility and efficacy of a single overnight polysomnography (PSG) CPAP titration versus APAP regarding effective pressure and residual apnea-hypopnea index (AHI) in PD patients with moderate-severe OSA.

Methods: Ambulatory PD patients with newly diagnosed OSA (AHI ≥ 15) used home APAP for one month and subsequently underwent PSG manual CPAP titration. Optimal, good, adequate and unacceptable CPAP titrations were defined according to AASM guidelines (Kushida, JCSM 2008). "Effective pressure" (P90) and residual respiratory disturbance index (RDI_{APAP}) were obtained from the APAP microprocessor.

Results: We studied 20 patients, 40% male, aged 65.0 ± 11.2 y (mean \pm SD), with body mass index (BMI) 28.2 ± 3.4 kg/m², Hohn & Yahr (H&Y) stage 2.4 ± 0.9 , AHI 30.6 ± 15.4 /h, and ODI 4.2 ± 8.2 /h. Out of 19 manual titrations, four (21%) were optimal, one (5%) good, nine (47%) adequate and five (26%) unacceptable (persistent elevated residual AHI). Comparing subjects with unacceptable titration (UnTitr) to others, there was no significant difference in mean age, BMI, AHI, levodopa-equivalent dose, H&Y or PD duration. However, UnTitr had significantly more sleep fragmentation during the titration PSG with a higher number of stage changes, awakenings, and total and spontaneous but not respiratory arousals. The effective CPAP (excluding UnTitr) was 7.6 ± 1.6 cmH₂O, whereas the P90 for APAP for these subjects was 8.3 ± 2.0 cmH₂O (p = 0.5, intraclass correlation coefficient [ICC] 0.354). Aver-

age nightly compliance with APAP was 3.7 ± 2.0 h, with RDI_{APAP} 5.5 ± 5.6 . Of the five UnTitr subjects, four had $RDI_{APAP} < 10$ (range 1.4-8.7).

Conclusion: Our results to date show that even after one month APAP use, a confirmatory manual CPAP titration was unsuccessful in one quarter of PD patients with OSA. APAP appears to be well-tolerated and may be an effective approach to OSA treatment in PD.

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0354

THE EFFECT OF MASK CHOICE ON RESIDUAL RESPIRATORY EVENTS WITH CONTINUOUS POSITIVE AIRWAY PRESSURE TREATMENT

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Introduction: It has been found that mask style can affect the amount of continuous positive airway pressure (CPAP) required to reduce an apnea/hypnea index (AHI) to < 5/hr on a titration study. However, it was not previously known whether switching from one CPAP mask style to another post-titration could affect residual AHI with CPAP. The purpose of this study was to investigate differences in residual AHI with CPAP treatment between oronasal and nasal masks.

Methods: 14 subjects were randomized to undergo an in-laboratory CPAP titration with either a nasal mask or oronasal mask. Subjects were then assigned this mask for three weeks of at-home CPAP use with the optimal treatment pressure determined on the laboratory study. At the end of this three-week period, data was collected from the CPAP machine, and the subject was given the other mask to use with the same CPAP settings for the next three weeks at-home (if nasal was given initially, the oronasal was given and vice versa). On completion of the second three-week period, data on residual AHI was again collected and compared to the first three-week period on CPAP.

Results: Pairwise comparison revealed that residual AHI with CPAP treatment was significantly higher with the oronasal compared to the nasal mask t(13) = -5.34, p < .001.

Conclusion: A higher residual AHI was seen in all patients with the use of an oronasal mask compared to a nasal mask. Switching to an oronasal mask post-titration results in an increase in residual AHI with CPAP treatment, and pressure adjustment may be warranted.

0355

ARE PATIENT AND STAFF BLINDING TECHNICALLY AND ETHICALLY FEASIBLE IN CROSS-OVER TRIALS FOR SLEEP APNEA USING PLACEBO/SHAM CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) DEVICES?

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Introduction: Clinical trials of CPAP therapy often use a sham CPAP device as a placebo. Unlike drug trials, current practice in cross-over CPAP trials is not to disclose the presence of a placebo device for fear of unblinding. In a randomised cross-over trial of placebo vs. real CPAP therapy, we 1) assessed the incidence of blinding failures in patients and asked them whether unblinding would definitely have occurred if the placebo control was disclosed at baseline, and 2) assessed blinding failures amongst staff members.

Methods: 1) Patient unblinding: Thirty-two patients underwent exit interviews. Patients were asked numerous questions about their treatment experience to ascertain whether they were unblinded. It was then disclosed that one device was in fact a placebo and they were asked

whether they would have been unblinded had this been disclosed at baseline.2) Staff unblinding: A questionnaire asked staff members if they were definitely unblinded, probably unblinded, or if neither, to just guess which treatment the patient was receiving.

Results: No patients reported being unblinded during the trial. After telling patients there was a placebo, 72% stated they would have been unblinded under full disclosure. Staff were certain that they were unblinded in 6% ($n = 16/282$) of recorded patient encounters and then usually correctly identified the treatment device (85%, $p < 0.01$). Eighty-two percent of these unblinding episodes occurred in the second arm. When staff thought they may have potentially been unblinded, they typically guessed correctly (61 encounters, 72% correct, $p = 0.0005$).

Conclusion: Patients were successfully blinded. Patient interviews corroborated that this was most likely because they were not told about a placebo device at the start of the trial. Staff unblinding occurs regularly, with many of these events occurring in the second arm. Placebo CPAP devices are not appropriate in cross-over studies as success depends on patient deception and staff unblinding commonly occurs.

0356

IMPACT OF A ONE-SESSION, GROUP CPAP ADHERENCE INTERVENTION ON SELF-EFFICACY AND CPAP USE IN VETERANS

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Introduction: Poor CPAP adherence is a well-known impediment to adequate treatment of sleep apnea. Clinical trials have shown that group interventions using social-cognitive techniques can improve CPAP use. We tested the impact of a one-session group intervention on CPAP use with newly diagnosed OSA patients.

Methods: Twenty-eight veterans who were naïve to CPAP attended a single CPAP adherence group session which addressed 1) risk perception 2) outcome expectation and 3) self-efficacy. Before and after the group session participants rated 1) the importance of and 2) their self-efficacy for using CPAP. Pts returned after 1 month for an adherence download. A longitudinal (4 weeks), linear mixed-effects model was fit for 2 outcome variables (Average Use and % Days Used). Predictors for these outcomes were post-tx importance and self-efficacy scores as well as the pre-to-post change scores for these measures.

Results: Significant increases were observed from pre-to-post tx for both importance ($mn = 4.5$, $sd = 14$; $p < .001$) and self-efficacy ($mn = 9.2$, $sd = 17$; $p < .001$). We found no relationship between post-tx scores of importance ($mn = 78$, $sd = 37$) or self-efficacy ($mn = 75$, $sd = 36$) with either outcome. Furthermore, the pre-to-post change in importance was not associated with either outcome. However, a larger change in self-efficacy predicted greater % Days Used during the 1st week ($p = .029$), but also predicted a more rapid decline in % Days Used than those with smaller changes in self-efficacy ($p = .014$).

Conclusion: A brief adherence intervention increased patient ratings of the importance of and self-efficacy for CPAP use. Increases in self-efficacy were related to greater % Nights Used, but not to Average Use. Finally, the greater % Nights Used was not sustained over the initial 4 weeks of PAP use. These findings suggest that a single session can improve self-efficacy for CPAP use initially; however, more intensive follow-up is likely needed to sustain higher levels of CPAP use during the first 4 weeks of treatment.

0357

PATTERN OF TIDAL VOLUME CHANGES DURING CPAP TITRATION POLYSOMNOGRAPHY

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Introduction: Behavioral factors are considered important in CPAP intolerance but physiologic correlates of CPAP intolerance are poorly understood. Sleep lab titration systems allow recording of tidal volume (Vt) and pressure during CPAP titration PSG. Changes in Vt during CPAP titration may be affected by individual characteristics such as loop gain, respiratory mechanics, CPAP level and many other factors. The pattern and degree of changes associated with sleep stages, arousals and respiratory events may affect and potentially predict CPAP tolerance. Here, we describe the pattern of Vt changes in subjects having CPAP titration PSG.

Methods: Consecutive patients undergoing a CPAP titration or Split PSG for sleep apnea from May to July 2013 were included. Vt recorded by ResMed's VPAP™ Tx sleep lab system was noted during awake and all sleep stages by taking an average of 10 breaths during that stage. Magnitude of change in Vt (ΔVt) associated with spontaneous arousal or after a respiratory event were noted along with CPAP pressure at the time. Pattern of Vt changes were analyzed with respect to sleep stages, optimum CPAP and AHI/RDI. Data are expressed as mean \pm SD. T-test and Correlation coefficients were used as appropriate.

Results: Baseline characteristics for 32 patients were: Age 54.2 ± 15 yrs, BMI 36.2 ± 7.7 , Males 56%, AHI $34.8 \pm 25.8/hr$, Nadir SpO₂ $79.6 \pm 6.3\%$. Vt (in ml) declined during sleep - Awake 506 ± 144 , REM 390 ± 87 , N1 429 ± 110 , N2 384 ± 82 , N3 367 ± 88 . Awake Vt was significantly correlated with optimum CPAP needed ($r = 0.31$, $p = 0.042$), with AHI ($r = 0.31$, $p = 0.041$) and RDI ($r = 0.35$, $p = 0.025$). ΔVt (ml) at termination of resp. event were: obstructive apnea 788 ± 358 , hypopnea 397 ± 324 , central apnea 659 ± 350 . There was a significant difference between ΔVt following OA vs. Hypopnea ($p = 0.0001$) and CA vs. Hypopnea ($p = 0.009$). Significant negative correlation was seen between ΔVt following spontaneous arousal in N3 and optimum CPAP ($r = -0.41$, $p = 0.01$).

Conclusion: In patients with sleep apnea on CPAP, Vt declines during sleep with largest drop in N3. Higher awake Vt on low CPAP pressure was associated with higher CPAP pressure requirements and higher RDI. We plan to study more patients to understand other relationships but these data suggest that analyzing respiratory patterns on CPAP may help to categorize physiologic responses to CPAP using parameters easily available on sleep studies. We are exploring these patterns to better understand the physiology of individual variation in CPAP response that may help to predict CPAP intolerance.

0358

POLYSOMNOGRAPHIC DETERMINANTS OF REQUIREMENT FOR ADVANCED POSITIVE PRESSURE THERAPEUTIC OPTIONS FOR OBSTRUCTIVE SLEEP APNEA

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Introduction: A small percentage of adult patients with severe obstructive sleep apnea (OSA) has been recognized to be extraordinarily difficult to treat with conventional continuous or bilevel positive airway pressure (together referred to as PAP) therapy. The aim of this study was to determine polysomnographic (PSG) characteristics, which may help predict the requirement for advanced therapeutic options for OSA.

Methods: Consecutive patients who underwent PAP titration at our Sleep laboratory over a 2-year period, were included. They were categorized into Group 1 (adequately PAP titrated); and Group 2 (poor PAP response). Patients with technically inadequate studies, those with incomplete titration due to intolerance, mask related problems or lack of sleep, and those with significant co-morbidity and with other primary sleep disorders, were excluded. PSGs were categorized into 3 types: A (respiratory events evenly distributed over all sleep stages), B (REM dominant), C (non REM dominant events alone, mainly during cyclic alternating pattern [CAP] sleep). Group A was further subdivided into A1 (those whose hypnogram normalized after titration), and A2 (those whose hypnogram converted to a type C pattern, on titration).

Results: Among 249 patients, 123 (103 males, mean age 49.9 ± 10.8 years, mean BMI 29.3 ± 4) fulfilled inclusion criteria. These could be grouped as A (85), B (33) and C (5). On titration, 57 in type A and 21 in type B, could be successfully titrated, while 24 in type A and 11 in type B, converted to type C. Thus, In group 2 ($n = 43$), 38 patients fell in type C, overtly or after titration. Twelve of these could be successfully treated using adaptive servo-ventilation (ASV) while another 28 could be treated using the bPAP-ST mode. The only PSG feature predicting poor PAP response was presence of post-arousal central apneas (< 0.001). On 1-year follow-up, 8 patients were using bPAP-ST mode, while 4 patients were using ASV and were asymptomatic.

Conclusion: Non-REM sleep instability and presence of post-arousal central apneas may be important determinants of poor response to conventional PAP and requirement for advanced therapeutic options among patients with severe OSA.

0359

EXHALED BREATH TEMPERATURE IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Intermittent hypoxia, a cardinal feature of obstructive sleep apnea (OSA), is known to cause activation of inflammatory pathways. Several studies have demonstrated elevated inflammatory markers in OSA patients compared to matched control subjects. In addition, patients with chronic inflammatory airway processes, such as asthma, have increased exhaled breath temperatures (EBT) compared to controls. We hypothesized that EBT may be elevated in OSA. We therefore performed this pilot study to determine if there was a correlation between EBT and disease severity as measured by the apnea-hypopnea index (AHI) in patients with OSA.

Methods: 42 patients (17 females and 25 males) referred to the sleep laboratory with suspected OSA were enrolled in this study. Mean age was 40.2 years (standard deviation [SD] ± 13.6 years), mean body mass index was 32.9 kg/square meter (SD ± 6.89), and mean neck circumference was 16.1 inches (SD ± 2.44). In addition to undergoing in-laboratory polysomnography to determine the AHI, all patients had EBT measurement with the X-Halo device (Delmedica Investments, Singapore). A plateau in breath temperature for 1 min with a minimum analysis time of 4 minutes was accepted as a good recording. The mean AHI was 25.7/hr (SD ± 24.2) and the mean breath temperature was 93.0 degrees fahrenheit (SD ± 1.037). Because neither AHI nor breath temperature was normally distributed, we used Spearman rank correlation coefficient (ρ) for analysis.

Results: There was no correlation between EBT and AHI ($\rho = -0.007$, $p = 0.964$).

Conclusion: On a preliminary basis, our pilot study could not detect any correlation between EBT and the severity of OSA as measured by the

AHI. Future studies may evaluate whether there is a correlation between changes in EBT and continuous positive airway pressure (CPAP) treatment in patients with OSA.

0360

A RESPIRATORY DISTURBANCE VARIABLE BASED ON THE ENVELOPE ANALYSIS OF THE AIRFLOW SIGNAL CAN REFLECT OXIMETRY EFFECTS OF DISTURBED BREATHING

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Introduction: We have proposed a new method to quantify sleep-disordered breathing (SDB) that, departing from event-oriented metrics such as AHI, extracts a continuous Respiratory Disturbance Variable (RDV). RDV is based on the normalized coefficient of variation of the envelope of the nasal-cannula signal as routinely recorded in polysomnographic (PSG) studies. Higher values of RDV reflect increasing departure from normal sinusoidal breathing, with the threshold for conventionally abnormal breathing being around 1.0. Here we report the relationship between a given level of RDV and the level of oximetry, a relevant recommended indicator of breathing disturbance effects.

Methods: In 10 PSG studies of moderate and severe obstructive sleep apnea (OSA) cases the RDV was calculated for each 30-second epoch. The full length of PSG studies was segmented according to RDV values. The RDV range 0.50-4.00 was subdivided into 14 categories using 0.25 unit grouping intervals. The oximetry variable was obtained as the percentile 25 of the 10 Hz readings for each epoch followed by a 5-epoch gaussian smoothing. For each RDV category, the average of the corresponding oximetry values was plotted. A simple linear regression model was calculated with the RDV level as the regressor and the oximetry as the regressand. The coefficient of determination (R-squared) assessed the goodness-of-fit of the regressions.

Results: Simple linear model using as regressor RDV in the range 0.5-4.0 and oximetry as regressand was highly significant. The adjusted R-squared was 0.547 ($p < .001$).

Conclusion: RDV, a measurement that can be automatically computed from routine PSG data, can appropriately reflect the effects of disturbed breathing on oximetry.

Support (If Any): This study was supported by FONIS grant SA12I2191.

0361

OUT OF CENTER SLEEP TESTING FOR OBSTRUCTIVE SLEEP APNEA: THE EXPERIENCE AT AN ACADEMIC SLEEP CENTER

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Introduction: Out of center sleep testing (OCST) with type-III studies are utilized with increasing frequency for the diagnosis of obstructive sleep apnea (OSA). OCST is validated in certain patient populations, but the effectiveness in clinical practice is less well known. This study evaluated the frequency of positive versus negative studies for obstructive sleep apnea and the occurrence of technical limitations.

Methods: This retrospective review included adults who completed a type-III study and comprehensive sleep evaluation from January 2011 through October 2013 at the University of Michigan Sleep Disorders Center. Type-III devices monitored: pulse oximetry with plethysmography, nasal pressure transducer with snoring, thoracic/ abdominal inductance plethysmography, body position, and electrocardiogram. Sleep technologist placed sensors and provided verbal and written information. Raw data was manually scored by a sleep technologist and reviewed and interpreted by a board certified sleep physician.

Results: Of the 147 completed studies, 72.6% studies were positive for OSA and 27.4% studies were negative and 12 (8.1%) were a failed study, defined as not interpretable due to technical issues. Males accounted for 56% of subjects and females 44%. There were no significant differences, for age (50.2 versus 47.4 years) or body mass index (32.1 versus 26.9 kg/m²) among positive and negative studies. Of the negative studies, 74% had significant obstructive respiratory events, but did not meet criteria for obstructive sleep apnea. Technical limitations were present in 22% of the studies, with poor nasal pressure signal and periods of lost pulse oximetry listed as the most frequent technical limitation. Among studies negative for OSA, 32% had technical limitations, compared to only 19% (P = 0.05) of positive studies.

Conclusion: When combined with a comprehensive sleep evaluation, OCST can effectively diagnose OSA in clinical practice. Technical limitations disproportionately affect negative studies and addressing these issues may improve the effectiveness of OCST.

0362

MIDDLE CEREBRAL ARTERY BLOOD FLOW VELOCITY IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME

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Introduction: The purpose of our study is to evaluate the effects of respiratory maneuver on the cerebral blood flow by measuring cerebral blood flow with Transcranial Doppler Ultrasound (TCD) in patients with obstructive sleep apnea syndrome (OSAS) subgroups and patients not having this diagnosis.

Methods: On our study, we have 30 high degree (AHI > 30/hour), 25 medium degree (AHI > 15-30/hour) and 22 light degree (AHI > 5-15/hour) OSAS patients with polysomnography (PSG) test results and 22 similar aged patients not OSAS diagnosed (AHI < 5/hour) which apply to Kahramanmaraş Sutcu Imam University Neurology Clinic with one or more of snoring, somnolence in day time or apnea symptoms which reported by patients adjacent. In the study group's blood flow rates, PI and RI measurements of both middle cerebral arteries (MCA) were evaluated with TCD. All results of the groups were compared. TCD measuring was done by Multi-Dop X, DWL and all tests were done after 10 minutes of rest. 2 MHz Doppler probe was used on supine position and sonography of both MCA was done from temporal bone window in 40-60 mm depth. Top-systolic (PV), end-diastolic (EDV) and mean blood flow rates (MV), Gosling's pulsatility index (PI) Pourcellet's resistance index (RI) of MCA were documented. Breath holding test was done to patients. Patients were told to hold their breaths as long as they can. It was provided to all patients to hold their breaths more than 10 seconds. At this point difference on cerebral blood flow rates were documented.

Results: When subgroup evaluating was excluded, TCD parameters compared in all patients at rest and apnea time, PV, EDV and MV measurements at apnea time were lower than at rest time. This difference was statistically significant. But when subgroups were compared difference was insignificant. Meanwhile all groups have increased PI measurements at apnea time. Although this difference was insignificant, this increase show us vascular resistance was increased too.

Conclusion: The study suggests that OSAS can be a risk factor in cerebrovascular diseases. In OSAS patients blood flow rates are lower than normal population and although insignificance in our study high PI measurements at apnea time can increase vascular resistance and this can lower cerebral perfusion which can cause higher stroke risk. So that both sleeping and apnea related decreased cerebral blood flow rates can cause cerebrovascular diseases in sleep time.

0363

BASELINE OXYGEN SATURATION IN EEG DETERMINED WAKEFULNESS IN RELATION TO SLEEP POSITION AND ITS CORRELATION TO HYPOXIC STRESS DURING SLEEP IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Poon et al. (SLEEP 2012) reported that in Level 3 monitoring one critical element to predict percent time less than 90% (O₂SAT90) as a marker for hypoxic stress was baseline saturation. This study explores whether Level 1 monitoring of position, sleep-wake variables, and oxygen saturation profiles contradict the findings from portable studies where EEG is not measured.

Methods: 100 consecutive diagnostic polysomnographic records (94 males and 6 females, age 51.4 ± 13.8 yrs (M ± SD); BMI 30.3 ± 5.7; ESS 9.5 ± 4.8; AHI 17.9 ± 19.9/hrs) were reviewed. Entered into analysis were baseline oxygen saturation during wakefulness in supine and non-supine position, and values of arousal index (AI), apnea hypopnea index (AHI), and oxygen saturation. Correlations among the variables, and a logistic regression with selected variables to predict O₂SAT90 were performed.

Results: Mean O₂ saturation during wakefulness was 94.7 ± 2.5% supine and 94.6 ± 2.3% non supine (p = 0.88), and not correlated to Body Mass Index (BMI). A moderate negative correlation (r = -0.64; p < 0.001) was present between baseline saturation and O₂SAT90. Other significant, moderate correlations were present among AHI and age, BMI, baseline saturation, O₂SAT90, and AI. To determine relative influences on O₂SAT90, the factors of age, BMI, baseline oxygen saturation, AI, and AHI were entered into a logistic regression which accounted for > 50% of the total variance (F = 17.18; p < 0.009) with the only significant variables being baseline saturation (p < 0.002) and age (p = 0.019). Elimination of AI made no difference.

Conclusion: During wakefulness baseline saturation does not depend upon position or BMI. As found previously, the degree of hypoxic stress depends more upon factors related to baseline oxygen saturation and age than AHI or BMI.

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0364

EVALUATION OF PHARYNGEAL COLLAPSIBLE SITES WITH MAGNETIC RESONANCE IMAGING IN OBSTRUCTIVE SLEEP APNEA PATIENTS DURING WAKEFULNESS

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Introduction: Upper airway closure is main reason for obstructive sleep apnea (OSA) and it usually occurs in the oropharynx, mostly in the retropalatal or in the retroglottal region or in both. Functional and anatomical abnormalities in these areas, even while the patients are awake, are thought to play an important role in the pathogenesis of OSA. We in-

investigated the anatomical characteristics of pharyngeal collapsible sites in OSA patients during wakefulness with magnetic resonance imaging (MRI) and explored its correlation with OSA severity.

Methods: Forty three subjects with OSA underwent overnight full polysomnography and cervical MRI with 1.5-tesla during wakefulness (age 56 ± 16 y, 79% male, with apnea-hypopnea index (AHI) 53.7 ± 26.4 , range AHI 26.4-123.3) and a body mass index (BMI) 29.0 ± 4.8). On the sagittal T1-weighted images from the epipharynx to the oropharynx, the posterior airway space (PAS) at level between first and second cervical body (C1-C2), at upper tip of third cervical body (C3), and at upper tip of fourth cervical body (C4) were measured. Those sites represent common collapsible region in OSA patients. Pearson correlation analysis was performed to examine the correlation between MRI measurement results and polysomnography parameters.

Results: PAS at upper tip of C4 had moderate, positive correlation with AHI ($r = 0.308$, $P < 0.05$) and supine AHI ($r = 0.401$, $P < 0.05$). Moreover, PAS at upper tip of C3 had moderate, positive correlation with apnea index ($r = 0.348$, $P < 0.05$) and supine AHI ($r = 0.463$, $P < 0.01$).

Conclusion: Our finding that upper airway diameters are wider in the severer OSA patients might be opposite to common sense when we consider that such places are under strong negative pressure during night. We, thus, speculate that this phenomenon may be a resultant positive remodeling to protect from high collapsibility or their airway and thus maintaining airway patency during wakefulness.

0365

COMPARISON OF RESIDUAL APNEA- HYPOPNEA INDICES (AHI) FROM ADHERENCE CARDS (AC) AND A LEVEL FOUR HOME SLEEP TESTING DEVICE

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Introduction: Data from continuous positive airway pressure (CPAP) AC are often used to measure residual AHI, allowing physicians to assess efficacy of therapy. However, correspondence of these measurements to other techniques is not well-established. The WatchPAT 100® (WP - Itamar Medical Ltd) is an FDA approved level 4 device for diagnosis of obstructive sleep apnea (OSA). We compared the correspondence of AHI between the two methods.

Methods: Forty OSA patients > 18 years (30M, 10F, age 55.7 ± 12 y, pretreatment median AHI 36.6) using CPAP (21 ResMed®, 14 Respironics®, 5 Fisher-Paykel®) complaining of residual sleepiness were given the WP to wear for 1 night while continuing CPAP treatment recorded on an AC. We compared AHI from the same night measured by WP to that from the AC. AHI measures from both instruments were assessed for determining efficacy of PAP treatment. “Successful” treatment was defined using 3 AHI thresholds: AHI < 5, AHI < 10 and AHI < 15.

Results: During treatment, the median AHIs were: for WP 5.4, for AC 2.9 ($P = 0.050$). AHIs obtained from the 2 methods were correlated: $AHI(WP) = 5.30 + (0.67 \times AHI(AC))$; $R = .64$, $p < .001$. For WP and AC, the success rates defined as AHI < 5/hour were 45% and 62% respectively ($p = 0.005$); for AHI < 10/hour, success rates were 62.5% and 82.5% respectively (NS; $p = .081$); for AHI < 15, success rates were 72.5% and 87.5% respectively (NP, $p = .117$).

Conclusion: While estimates of AHI on treatment are correlated, the WP gives consistently higher values than the AC. Hence, the “success” rates between the two methods differ. However, as the AHI used to define success increases, there are fewer disagreements in the functional outcome or decisions to change treatment. Decisions to change treatment should take into account the method used to assess success or failure.

0366

APNEA-HYPOPNEA DURATION INDICES FOR THE ASSESSMENT OF OBSTRUCTIVE SLEEP APNEA SEVERITY

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Introduction: The severity of OSA could be related to the duration of apneas and hypopneas during sleep. Apnea Duration (AD), Apnea/Hypopnea Duration (AHD), Apnea Duration Index (ADI) and Apnea/Hypopnea Duration Index (AHDHI) can be easily measured. We assess the contribution of these duration parameters, in comparison to the traditional AI and AHI, as a measurement of OSA severity.

Methods: AD, AHD, ADI and AHDHI were assessed in 973 (767 (78.8%) males) consecutive OSA adult patients (Age = 53.1 ± 12.4 , BMI = 31.1 ± 5.4 , AHI = 37.6 ± 25.7) who underwent a sleep evaluation at our Sleep Disorders Unit.

Results: Mean (\pm SD) AD, AHD, (minutes) and ADI, AHDHI for the whole group were 41.7 ± 59.0 ; 96.9 ± 68.1 and 7.2 ± 9.9 ; 17.0 ± 11.4 , respectively. The correlations between AI and ADI and for AHI and AHDHI were $r = 0.96$ and $r = 0.92$ respectively. The correlations between AI and ADI for mild, moderate and severe OSA were: $r = 0.95$, $r = 0.95$ and $r = 0.92$, respectively while the correlations between AHI and AHDHI for mild, moderate and severe OSA were: $r = 0.65$, $r = 0.72$ and $r = 0.71$, respectively. The Pearson r and r^2 values for AHDHI matched with TST 90%, Min SaO₂ in REM and NREM were better than for AHI (0.65, 0.42; -0.64, 0.41; and -0.67, 0.44, respectively). All the correlations were found significant ($p < 0.001$).

Conclusion: ADI and AHDHI are in very good agreement with AI and AHI. The correlation and explained variance of the indices of ADI and AHDHI for, TST 90%, Min SaO₂ in REM and NREM were better than AI and AHI. Additional studies to evaluate the sensitivity of ADI and AHDHI for determination of treatment outcomes of patients with OSA are needed.

0367

DIAGNOSIS AND DYNAMIC MONITORING OF OBSTRUCTIVE SLEEP APNEA IN PATIENTS WITH END-STAGE RENAL DISEASE BEFORE AND AFTER HEMODIALYSIS USING PERIPHERAL ARTERIAL TONOMETRY

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Introduction: Obstructive sleep apnea (OSA) affects approximately one in five adults in the general population and is even more common in patients on hemodialysis (HD). The extracellular fluid volume, especially upper airway mucosal edema, and metabolic derangements that characterize the uremic state likely contribute to OSA in the HD population. The objective of this study was to evaluate the effect of different interdialytic intervals on the severity of OSA, as measured by a portable sleep study.

Methods: A convenience sample included eight patients (age 61.3 ± 7.5 years; 62.5% male) receiving HD for more than six months without a previous diagnosis of OSA but with a high risk of OSA, as indicated by a STOP-BANG (validated OSA screening questionnaire) score of ≥ 3 . Severity of OSA was measured using WatchPAT, a validated home monitoring device, for three consecutive nights: the day of HD, one day after HD, and two days after HD. Respiratory disturbance index (RDI), apnea-hypopnea index (AHI), blood oxygen saturation level (ODI), mean heart rate, and sleep/wake states were recorded.

Results: Across the three nights of home monitoring device use, average \pm SD RDI was 30.4 ± 17.8 , 27.8 ± 21.4 , and 29.9 ± 21.9 ; AHI was 29.4 ± 18.2 , 27.0 ± 21.7 , and 29.4 ± 22.1 ; ODI was 21.4 ± 17.1 , 19.6 ± 20.5 , and 22.2 ± 22.1 . Mean heart rate (beats/minute) was 72.4 ± 8.7 , 71.0 ± 10.4 , and 71.1 ± 10.4 ; average percent of recording time spent in a sleep state was 76.3 ± 13.9 , 76.4 ± 18.5 , and 74.6 ± 12.2 across nights one, two, and three, respectively.

Conclusion: In this small sample of HD patients, use of a portable sleep study showed no differences in RDI, AHI, ODI, mean heart rate, or sleep/wake state across the three nights. Therefore, these preliminary data suggest that the duration of interdialytic interval does not affect the severity of OSA and sleep studies may be conducted without regard to interdialytic interval for the purposes of OSA diagnosis.

0368

PREDICTORS OF A DIAGNOSTIC HOME SLEEP TEST IN VETERANS

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Introduction: The Greater Los Angeles VA (VAGLA) received 3,737 new sleep consults in fiscal year 2013, with the majority of referrals for the evaluation of obstructive sleep apnea (OSA). Individuals assessed as high risk for OSA by a sleep physician are referred directly for a home sleep test (HST) which can result in a diagnostic HST (OSA; AHI > 5) or a non-diagnostic HST (data loss or AHI < 5). A non-diagnostic HST results in diagnostic delays and increased cost of diagnosis. We attempted to assess predictors of a diagnostic HST using three brief questionnaires administered to patients in the VAGLA sleep clinics.

Methods: 90 individuals (mean age = 53.6 years) referred for HST (Stardust II, Philips Respironics) from 9/2013-12/2013 completed the Epworth Sleepiness Scale (ESS), the STOP-BANG, and the Insomnia Severity Index (ISI). The HST was manually scored by a certified sleep technician using AASM guidelines and reviewed by a sleep physician. Study results were defined as either diagnostic or non-diagnostic for OSA based on the clinical interpretation. Logistic regression models predicting diagnostic vs. non-diagnostic HST were examined with each questionnaire (ISI, ESS and STOP-BANG) tested individually and simultaneously as predictors.

Results: When tested individually, lower ESS (OR = .91, $p = .012$, area under ROC curve = .660), lower ISI (OR = .91, $p = .010$, area under ROC curve = .648), and higher STOP-BANG (OR = 1.64, $p = .005$, area under ROC curve = .688) predicted higher likelihood of a diagnostic HST. When examined simultaneously, the three questionnaires (ISI OR = .86, STOP-BANG OR = 2.19, and ISI OR = .91) had an area under ROC curve of .805 for predicting a diagnostic HST (model $p < .001$).

Conclusion: Veterans with higher scores on the STOP-BANG and lower scores on the ESS and the ISI were most likely to have a diagnostic HST. Findings suggest these three brief questionnaires together have high predictive value in determining which patients are likely to have a diagnostic HST.

Support (If Any): VARRD000135-01.

0369

THE DIFFERENT ASSOCIATIONS AMONG OBESITY MEASURES WITH APNEA-HYPOPNEA INDEX ACROSS THE AGE SPAN

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Introduction: Obstructive sleep apnea syndrome (OSAS) prevalence is known to increase with age and obesity. Body fat distribution represent-

ing obesity tends to change with age and may affect OSAS severity such as apnea-hypopnea index (AHI). We aimed to examine how obesity measures influence AHI across the age span.

Methods: The data of 1,110 subjects diagnosed as OSAS by nocturnal polysomnography were evaluated. Subjects were divided into six age groups: groups of 18-29 ($n = 76$), 30-39 ($n = 127$), 40-49 ($n = 191$), 50-59 ($n = 351$), 60-69 ($n = 247$), and above 70 years ($n = 118$). AHI and obesity measures including body mass index (BMI), neck circumference (NC), waist circumference (WC), and waist-to-hip ratio (WHR) of the subjects were analyzed. In each age group, partial correlation analyses with gender controlled were conducted between AHI and obesity measures and multiple linear regression analyses in a stepwise method were performed for AHI with obesity measures and gender as covariates.

Results: The AHI, BMI, NC, WC, and WHR significantly differed among the six age groups. In the groups of 18-29 and above 70 years, only WC significantly correlated with AHI. In the group of 30-39 years, BMI, NC, and WC significantly correlated with AHI. In the groups of 40-49, 50-59, and 60-69 years, all four obesity measures correlated with AHI. Of the variance in AHI, obesity measures accounted for 8.3%, 9.9%, 14.9%, 26.2%, 20.6%, 4.7% for the groups of 18-29, 30-39, 40-49, 50-59, 60-69, and above 70 years, respectively.

Conclusion: Body fat distribution contributes to OSAS severity in different ways across the age span. Compared with the middle-aged groups, younger- and older-aged groups have less association between AHI and obesity measures. The findings suggest that the treatment strategy such as weight loss might have different outcome across the age span.

0370

CHARACTERISTICS OF QUANTITATIVE SLEEP EEG IN YOUNG AND ELDERLY PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME

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Introduction: Sleep fragmentation and oxygen desaturation in obstructive sleep apnea syndrome (OSAS) deteriorate sleep quality and may induce brain dysfunctions. Compensatory mechanism of brain can be disturbed with aging. We hypothesized that sleep EEG activities could distinguish young (< 30 yrs) and elderly (> 55 yrs) OSAS groups.

Methods: EEG recordings of 76 OSAS patients (young group: $n = 40$, mean age 25.1 ± 5.9 ; elderly group: $n = 36$, mean age 57.6 ± 1.1) during nocturnal polysomnography were analyzed using spectral analysis in frequency bands of delta (0.5-3 Hz), theta (4-7 Hz), slow sigma (11-13 Hz) and fast sigma (13-17 Hz). Correlations of quantitative EEG measures to apnea-hypopnea index (AHI) were explored.

Results: AHI and sleep efficiency (%) showed no significant differences between the young and elderly groups (19.8 ± 14.4 vs. 27.0 ± 17.8 , $p = 0.056$; 84.4 ± 12.6 vs. 80.9 ± 11.0 , $p = 0.198$, respectively). REM sleep (%) was significantly higher in the elderly group vs. the young group (28.9 ± 18.6 vs. 40.6 ± 19.0 , $p = 0.008$). Delta activity was significantly higher in the young group vs. the elderly group (88.6 ± 5.5 vs. 82.9 ± 5.0 , $p < 0.001$). Elderly group showed higher theta and slow and fast sigma powers, compared with the young group (5.0 ± 3.8 vs. 8.3 ± 2.6 , $p = 0.002$; 1.1 ± 0.6 vs. 1.6 ± 0.4 , $p < 0.001$; 1.2 ± 0.8 vs. 1.7 ± 0.6 , $p = 0.014$, respectively). In the young group, sleep efficiency was inversely correlated with AHI ($r = -0.379$, $p = 0.016$), but in the elderly group REM sleep (%) showed an inverse correlation with AHI ($r = -0.373$, $p = 0.025$). Delta activity did not show significant correlations with AHI in both young and elderly group ($p = 0.362$, $p = 0.490$, respectively). The slow/ fast sigma

ratio showed an inverse correlation with AHI in the young group ($r = -0.420$, $p = 0.007$) but not in the elderly ($r = -0.145$, $p = 0.397$).

Conclusion: In current study, sleep EEG activities showed different characteristics between young and elderly OSAS patients. Slow /fast sigma ratio was associated with OSAS severity only in the young group. These results suggest that OSAS may induce different changes of brain function in the elderly patient from young patients.

0371

COMPARISON OF A SIMPLE SLEEP APNEA SCREENING DEVICE WITH STANDARD IN-LAB POLYSOMNOGRAPHY

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Introduction: Sleep apnea is a common, underdiagnosed disorder. Various strategies have been employed to perform screening and/or diagnosis. The ApneaStrip® (AS - S.L.P. Ltd, Tel Aviv, Israel) is an FDA approved simple to use sleep apnea screening device applied by the patient to his/her upper lip at home. We evaluated the performance of this device against simultaneous in-lab polysomnography (PSG) in a group of well characterized obstructive sleep apnea (OSA) patients.

Methods: Routine diagnostic PSG was performed in 44 patients (19M, 25F); age 49.9 ± 14.0 y; body mass index (BMI) 37.9 ± 9.2 kg/m²; apnea-hypopnea index (events/hour; AHI) 31.1 ± 23.5 . The AS was applied to the upper lip with thermistors positioned to detect nasal and oral airflow. The AS gives a “positive” result if the AHI is > 15 (proprietary algorithm). We examined the sensitivity and specificity of the AS for detection of sleep apnea against 3 thresholds derived from PSG testing: AHI > 5 , AHI > 15 (company recommendation), and AHI > 30 .

Results: For PSG AHI > 15 , the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the AS were 86.2%, 62.5%, 89.3%, and 55.5%, respectively. For PSG AHI > 5 the values were 80%, 28.5%, 100%, and 22%, respectively. For PSG AHI > 30 the values were 70.8%, 11.1%, 60.7%, and 22.2%, respectively. At all AHI thresholds, there were no significant effects of demographic and comorbid conditions including BMI, gender, hypertension, diabetes, lung disease, seasonal allergy and heart disease. Results were inconclusive or there was a malfunction in 7/44 (15.9%). Failure to collect data was not predicted by AHI or any of the above factors.

Conclusion: The AS has a high sensitivity for detection of OSA with AHI > 15 , but only modest specificity, with a small device failure rate. The AS could be a useful component of a sleep apnea screening program, however negative results should be interpreted cautiously.

Support (If Any): S.L.P. Ltd Tel-Aviv donated the ApneaStrips used for this study.

0372

USING FENO AND STOP-BANG SCORES TO PREDICT AHI IN OSA PATIENTS

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Introduction: The STOP-BANG questionnaire is a simple, validated 8-point screening tool for obstructive sleep apnea (OSA) with high sensitivity, reasonable accuracy and user-friendliness. A score of ≥ 3 indicates a high risk for presence of OSA. Elevated fraction of exhaled nitric oxide (FENO) levels, reflecting airway inflammation, have been demonstrated in untreated OSA patients and correlate with the apnea-hypopnea index (AHI). Using the portable NIOX MINO® NO analyzer (aerocrine; Sweden), we examined FENO levels in healthy OSA patients and assessed the utility of this simple bedside screening tool combined with the STOP-BANG questionnaire in predicting AHI.

Methods: We prospectively enrolled 104 consecutive non-smokers ≥ 18 years without cardio-respiratory, allergic or systemic diseases. In each subject, we measured FENO levels immediately before an overnight polysomnogram and computed the STOP-BANG scores. Regression analysis was obtained to determine whether the AHI correlated with the FENO and STOP-BANG score.

Results: Mean age of the population was 46 ± 14 years and 57% were males. Mean BMI and AHI were 37.0 ± 10.3 kg/m² and 40 ± 33 h⁻¹ respectively. Seventy-five had OSA with an AHI ≥ 5 . The AHI was significantly correlated with the FENO levels ($r = 0.72$, $p < 0.001$) and with the STOP-BANG ($r = 0.50$, $p < 0.001$). In a regression model incorporating the FENO and the STOP-BANG, both remained independent predictors of the AHI and there was no collinearity between the two variables. This model explained 54% of the variance in AHI, and the AHI could be estimated as: $AHI = 2.3 \times FENO + 2.9 \times STOP-BANG - 13$.

Conclusion: Clinical and physiologic features of obstructive sleep apnea, as captured by the STOP-BANG scores and FENO respectively, complement each other to predict AHI. Measuring FENO combined with the STOP-BANG questionnaire may be a simple way of screening for OSA and assessing its severity.

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0373

NECK-HEIGHT RATIO (NHR) PREDICTS OBSTRUCTIVE SLEEP APNEA (OSA) SEVERITY AFTER CORRECTION FOR OTHER PREDICTORS

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Introduction: Airway occlusion may be more likely related to proximal neck anatomic factors than to general risk factors. The aim of this study is to determine if the NHR predicts OSA severity at the apnea hypopnea index (AHI) cut-offs of 15 and 30, after other factors are controlled for.

Methods: First-time computerized self-report responses were linked cross-sectionally to clinical and PSG data of 2577 patients (age-range 18-95) with complete data from 1-1-08 through 9-28-12. Stepwise logistic regressions tested the conjoint effects of NHR, age, gender, and BMI, along with interactions, to determine statistically significant factors increasing severities above the cutoffs.

Results: Mean subject age was (51.7 y SD13.9; M = 65%; F = 35%). Most were between 40-60 yr old (52%). NHR (mean; SD) ranged from 0.154 to 0.38 (0.234, 0.02), BMI from 15.2 to 49.88 (32.86, 6.64) and total AHI from 5 to 149 (20.8, 14.7). Correlation between AHI and NHR was 0.29. For the model utilizing the AHI 15 cutoff as dependent variable, the final selected stepwise regression model showed NHR had independent odds of prediction (OR/Unit = 1.3×10^7 ; CI = 7.2×10^4 , 2.5×10^9 ; $p < 10 \times 10^{-9}$), after correction for age (OR/year = 1.03; CI = 1.02, 1.04; $p \sim 10 \times 10^{-20}$), being male (OR = 2.05; CI = 1.69, 2.5; $p \sim 10 \times 10^{-13}$) and higher BMI (OR/BMIunit = 1.03; CI = 1.01, 10.4; $p = 0.0013$). Interaction terms crossing these factors were non-significant. A similar model structure was found for the AHI 30 outcome overall, with now the interaction term between NHR and BMI approaching significance ($p = 0.06$) in the final tested, but non-significant model.

Conclusion: NHR is an additional predictive factor for the severity of OSA, after correcting for other factors known to be predictive for OSA. For this reason, NHR should be considered a reportable risk factor in future studies.

Support (If Any): Knowledge Project Program, Neurological Clinic, Cleveland Clinic Foundation.

0374

THE POSSIBLE ROLE OF K-COMPLEX IN OBSTRUCTIVE SLEEP APNEA - HYPOPNEA SYNDROME

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Introduction: A K-complex (K-C) is one of the important waves in defining stage N2 sleep. In addition, K-Cs occur spontaneously but also in response to external stimuli such as sounds and touch and internal stimuli such as inspiratory interruptions. The function of K-C has been suggested to be the suppression of cortical arousal in response to stimuli that the sleeping brain evaluates as benign, and to aid sleep-based memory consolidation. However, the clinical significance of K-Cs remains unknown in patients with sleep apnea-hypopnea syndrome (OSAHS). To determine the clinical significance of K-Cs in OSAHS, we analyzed the number of K-Cs and sleep parameters on polysomnography (PSG) in patients with OSAHS.

Methods: The K-C index, sleep efficiency (SE), arousal index, apnea-hypopnea index (AHI), sleep fragmentation time (SFT), and ratio of wake time during sleep (% wake) were analyzed by performing diagnostic PSGs in 50 males. The K-C index was calculated as the number of K-Cs divided by the total sleep time (TST).

Results: There were no significant differences in the K-C index and SE, %wake, AHI, or SFT in OSAHS patients. However, a weak negative correlation ($r = -0.525$) in patients with mild to moderate OSAHS ($5 \leq \text{AHI} < 30$) was observed between the K-C index and arousal index. In addition, the increased K-C index in patients with 5 to 30 of AHI was observed compared to that in patients with less than 5 of AHI ($p = 0.047$).

Conclusion: The data might suggest that K-Cs reduce the cortical response elicited on inspiratory occlusions.

0375

DOES A “SHORT THICK NECK” PREDICT OBSTRUCTIVE SLEEP APNEA (OSA)?

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Introduction: OSA is commonly seen in patients who are obese. A “short thick neck” is classically described in patients with Pickwickian (obesity hypoventilation) syndrome, over 90% of who have OSA. A short neck (unlike a thick neck) has not been studied as a predictor of OSA. We sought to assess if a “short thick neck” predicts OSA.

Methods: 169 patients over 18 years of age, underwent a PSG for clinical suspicion of OSA. Neck circumference was measured at the cricothyroid membrane, and laryngeal height was measured from the top of the thyroid cartilage to the suprasternal notch. AHI, baseline SAO_2 , nadir SAO_2 , and serum bicarbonate (surrogate marker for pCO_2) were the 4 dependent variables. Statistical analyses were performed to evaluate the interactions between neck circumference, laryngeal height, and the 4 dependent variables.

Results: There was no significant association between laryngeal height and the four dependent parameters (adjusted $p = 0.689$ for AHI, 0.489 for bicarbonate, 0.920 for baseline oxygen saturation, and 0.822 for nadir oxygen saturation). Neck circumference was also not significantly associated with any of the four dependent variables, although the association between neck circumference and AHI approached significance ($p = 0.055$). To determine if neck circumference and laryngeal height

have an effect jointly, i.e., the “short and thick neck” hypothesis, we analyzed short (dichotomized as ≥ 4 vs. < 4 cm and thick (dichotomized as ≥ 40 vs. < 40 cm) necks against the 4 dependent variables. Short and thick neck (12 patients) seemed to be associated with lower nadir SAO_2 (p -value = 0.018). Patients in this group had more severe OSA (mean AHI 30.4) but this did not reach statistical significance (p -value = 0.242).

Conclusion: A “short thick neck” does not predict sleep apnea. It may be associated with more severe oxygen desaturation in patients with OSA.

0376

IS THE CHRONOTYPE RELATED TO SEVERITY OF OBSTRUCTIVE SLEEP APNEA?

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Introduction: Chronotype and obstructive sleep apnea (OSA) have ontogenic components. After 60 years of age, individuals shift to the morningness chronotype and exhibit an increase of OSA severity and prevalence. Additionally, body mass index (BMI) influences the occurrence of sleep-disordered breathing and can be associated with sleep timing preference. Therefore, chronotype and OSA appear to have a similar lifelong evolution, which could indicate a possible effect of morningness or eveningness in the apnea-hypopnea index (AHI). The present study aimed to examine the prevalence of chronotypes in a representative sample of São Paulo city residents and to investigate the effect of chronotypes on the severity of OSA.

Methods: We performed a retrospective analysis using the São Paulo Epidemiologic Sleep Study (EPISONO). In total, 856 participants underwent a full-night polysomnography and completed the Morningness-eveningness, Epworth Sleepiness Scale, and UNIFESP Sleep questionnaires. Chronotypes were classified as morning-type, evening-type, and intermediate.

Results: Morning-type individuals represented 52.1% of the sample, followed by intermediate (39.5%) and evening-type (8.4%) individuals. Morning-type individuals were, on average, approximately 10 years older than the other 2 groups. BMI was significantly higher in morning-type individuals compared to intermediate chronotype. The mean scores determined from the Epworth Scale were similar among the groups and were within the normal somnolence range (< 10). Sleep debt was lower in the morning-type compared with the intermediate chronotype and exhibited a significant effect of age. After stratifying the sample by BMI ($> 26.8 \text{ kg/m}^2$) and age (> 42 years), we observed increased AHI values in morning- and evening-type individuals.

Conclusion: We demonstrated, for the first time, an age- and BMI-related effect of morning- and evening-types in OSA severity, suggesting that the intermediate chronotype might play a role as a protective factor in older and overweight patients.

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0377

INABILITY TO FIT PATIENT'S HANDS AROUND NECK AS A PREDICTOR OF OBSTRUCTIVE SLEEP APNEA

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Introduction: While obstructive sleep apnea (OSA) has been correlated with a large neck circumference, the utility of neck circumference as a diagnostic tool has been limited. We proposed to find a simple test that could help clinicians identify patients with OSA. We hypothesized that the inability of the patient to fit their hands around their neck was predictive of OSA.

Methods: This pilot study evaluated subjects seen in a sleep clinic. They were assessed using the Neck Apnea Predictor (NAP) test. NAP positive was defined as the inability to place the hands around the neck with digits touching in the anterior and posterior. NAP negative was the ability to place hands around the neck. Subjects were subsequently evaluated by overnight polysomnography or type IV home test. The studies were scored using the AASM manual criteria. Positive for OSA was defined as an AHI ≥ 5 .

Results: A total of 47 subjects (36% female) were evaluated. The mean age was 51.6 (SD 14.4, range 29-81). The mean BMI was 39.8 (SD 12.9, range 20.4-90.8). 87.2% (n = 41) tested positive for OSA by AHI. The sensitivity of NAP was 68.3% and the specificity was 100%. The positive predictive power was 100% and the negative predictive power was 31.6%.

Conclusion: As we hypothesized, NAP positive (inability to span neck) was predictive of OSA in this population of sleep clinic patients. A NAP positive test was 100% predictive of the presence of OSA (AHI ≥ 5), but less useful at ruling out OSA as demonstrated by the poor negative predictive power of 31.6%. NAP shows promise for ease of clinical use and the fact that its high positive predictive value may remove the necessity of extensive testing for OSA. Further study is needed to evaluate its effectiveness in a general primary care population.

0378

AUTONOMIC FUNCTIONS IN ADULT PATIENTS WITH MODERATE AND SEVERE OBSTRUCTIVE SLEEP APNEA SYNDROME

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Introduction: Obstructive sleep apnea syndrome (OSAS) is a common sleep related disorder in adult patients. The changes in autonomic activity of OSAS patients might be primarily related to reduced nocturnal oxygen saturation. The objective of this study was to evaluate the relationship of autonomic functions to OSAS severity.

Methods: Twenty-one patients with obstructive sleep apnea syndrome (Groups 1-2) and 29 controls (Group 3) were included in the study. Patients were diagnosed as OSAS by polysomnographical (PSG) recordings. Eight of the patients had moderate (Group 1) and 13 of them had severe OSAS (Group 2). Latencies of the sympathetic skin responses (SSR) and mean RR intervals (RRI) were performed. SSR, RRI during hyperventilation were compared within the groups. Diabetes and other peripheral neuropathies were excluded by laboratory and EMG techniques. T-Test, Mann-Whitney Tests and Kruskal-Wallis tests were used when comparing the results statistically.

Results: The body mass index (BMI) results of OSAS group were greater than the controls (p < 0.05). In 3 of the OSAS patients the SSR could not be obtained. Although there was no significant difference, the SSR latency results of the group 2 was higher than the group 3 (1154.61 \pm 184.63 msec and 1492.93 \pm 53.77 msec). No statistically significant differences could be found between the three groups when the RRI results and SSR were compared with each other (p > 0.05).

Conclusion: We conclude that RRI and SSR findings showed no significant difference between the 3 groups. Such easily performed measurements could be done for the OSAS patients when autonomic functions are considered.

0379

OUTCOMES OF SPLIT NIGHT VERSUS FULL NIGHT CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) TITRATION STUDIES IN ACHIEVING THE OPTIMAL CPAP PRESSURE IN PATIENTS WITH SEVERE OBSTRUCTIVE SLEEP APNEA (OSA)

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Introduction: Traditionally, a full night CPAP titration study was used to determine the optimal pressure for treatment of moderate to severe OSA diagnosed by a full night polysomnography (PSG). More recently, split-night PSG has been employed for potential cost savings and to expedite treatment. This involves initial 2 hrs of diagnostic PSG followed by CPAP titration in the remaining 4 hours, on the same night. There is concern that split-night studies do not provide sufficient time for optimal CPAP titration and may not avert the need for a subsequent full night study.

Methods: The optimal pressure is one that reduces the AHI below 5/ hour for ≥ 15 minutes, including ≥ 5 min of supine REM sleep, uninterrupted by frequent arousals. In our cross sectional study, we reviewed 224 consecutive, eligible CPAP studies (full night = 133, split-night = 91), comparing their prescription pressures based on 3 primary outcomes: reduction of AHI < 5/hr, achievement of ≥ 5 min of supine REM sleep, and maintenance of an O₂ saturation nadir or the average O₂ saturation $\geq 90\%$ on that pressure.

Results: Full night CPAP studies are more likely to achieve all three outcomes together (p < 0.0001) than a split night study. They are also more likely to achieve AHI ≤ 5 hr (p = 0.037). There was not, however, a statistically significant difference between the 2 types of studies with regards to achieving ≥ 5 minutes of supine REM sleep (p = 0.7793) or O₂ sat nadir $\geq 90\%$ (p = 0.079).

Conclusion: A full night CPAP study was 3.68 times more likely to yield an optimal pressure, incorporating all 3 of the primary outcomes together, and 1.83 times more likely to achieve the outcome of AHI ≤ 5 /hr compared to a split night study. There was not, however, a statistically significant difference between the 2 types of studies with regards to achieving the other outcomes individually.

0380

EVALUATION OF THE ARABIC VERSION OF STOP BANG QUESTIONNAIRE AS A SCREENING TOOL FOR OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is a sleep-related breathing disorder that is underdiagnosed. Untreated OSA could lead to life threatening complications. OSA usually diagnosed by polysomnography (PSG). Many screening questionnaires were developed to screen and identify patients at high risk for OSA. This study aim to evaluate and validate the Arabic version of STOP BANG questionnaire as a screening tool for patients with OSA symptoms referred to sleep clinic.

Methods: All referred Arabic speaking adult patients presented to Sleep Disorders Specialized Clinic in Al Ain for PSG were requested to answer an Arabic STOP BANG questionnaire. A score of 3 or more out of a possible 8 was taken to indicate high risk for presence of OSA. These were then evaluated versus results from the overnight, monitored PSG.

Apneas/Hypopnea Index AHI of ≥ 5 /Hour was considered for diagnosis of OSA.

Results: One hundred ninety three sleep clinic patients were enrolled in this study. PSG was positive (AHI ≥ 5) in 85% of the studied population. STOP BANG questionnaire was positive (≥ 3) in 87% of the population. Reproducibility of STOP BANG questionnaire was tested and the intra-class correlation coefficient of the total score of STOP BANG questionnaire was 0.931 (95% CI 0.834-0.972). The sensitivities of the STOP BANG screening tool for an AHI of ≥ 5 , ≥ 15 , and ≥ 30 were 90%, 96.75%, and 99.70%, respectively, with negative predictive values of 36%, 84% and 92%, respectively. ROC curve was 0.77.

Conclusion: The Arabic version of STOP BANG questionnaire is an easy to use tool that can be used as a reliable and quick screening tool for OSA in non-surgical patients. It demonstrated high sensitivity and NPV especially for patients with moderate to severe OSA. We believe that this tool will help physicians to identify earlier cases at risk of OSA and as a consequence it might delay or prevent OSA complications.

0381

SLEEP DISORDERED BREATHING IN DOMBIVLI AND MUMBAI (INDIA): INTERESTING OBSERVATIONS

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Introduction: Patients reported to the first author in response to exhibits on snoring put up at Ambika clinic and hospitals (Dr. L.H. Hiranandani Hospital, Mumbai and Asian Institute of Medical Sciences, Dombivli). A total of 133 patients suffering from habitual snoring were evaluated between January 2008 and December 2011. Clinical examination—BMI, neck circumference, a sleep questionnaire—mood swings, sleep times, snoring, parasomnias viz bruxism, somniloquy, nocturia (frequency and time), drooling, sleep posture, daytime sleepiness (ESS), appetite, and fast eating.

Methods: Polysomnography was done using Alice 5 sleep laboratory in the hospital. The age of patients ranged between 20 years and 76 years. The mean BMI was 28.2. The mean neck circumference was 37.3 cms. Clinical observations: Mood swings (emotional outbursts): 63.1%, macroglossia: 84.9%, fast eating: 62%, oedema feet and legs: 14.28%, bruxism: 9.7%, sleep starts (jerking and fear of falling from bed): 48.8%, sleep talking: 21.8%, nocturia: 40.6% (21% had at fixed times like an alarm clock). Majority of the patients 95% slept on sides often adopting a semi-prone and prone position during early morning hours.

Results: Polysomnographic observations revealed: Primary snoring: (25) 18.7%, UARS: (19) 14.28%, mild OSA: (20) 15.0%, moderate OSA: (36) 27.06%, severe OSA: (33) 24.8%. The most common associated disorders were hypertension and type 2 diabetes mellitus. REM sleep was deficient, below 18% in all patients who exhibited fast eating. CPAP therapy was offered to patients suffering from UARS and OSA. Only 38 (35.1%) patients accepted it and are leading a good quality of life. Patients with primary snoring were advised follow-up.

Conclusion: Habitual snoring needs attention. Improved public awareness is the key to the growth of sleep medicine, particularly in developing countries like India.

0382

SCREENING MODEL FOR THE PREDICTION OF OBSTRUCTIVE SLEEP APNEA IN ADULTS

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Introduction: Obstructive sleep apnea (OSA) is a prevalent and serious sleep disturbance, which often goes undiagnosed. There are a few

screening questionnaires used in research, but a gap remains in evidence of specific questions/signs/symptoms that providers can use to efficiently and succinctly screen for OSA in the clinic setting. The objective of this study was to test the best predictors of OSA.

Methods: A nested investigation within a larger prospective study of community-dealing residents was performed. Subjects were recruited from the community at large to undergo study procedures. Participants attended one study visit where they completed questionnaires: BFRSS sleep questions, ISI, ESS, SDQ, PROMIS-57 and demographics/medical, then wore a OSA screening device for one night. Descriptive statistics of the study sample the each hypothesized variable was tested for significance using a chi square test before including it in the model. The final model including the following variables: severity of snoring, race, ethnicity, education was entered into a logistic regression analysis predicting the binary outcome of the presence or absence of obstructive sleep apnea was run utilizing SPSS software.

Results: 254 participants, 66% females, 83% white, mean age was 40.78 (SD = 17.21) years, mean AHI was 4.66 (SD = 8.37), mean neck circumference was 38.67 cm (SD = 73.44), mean BMI 27.8056 (SD = 6.79). 30% of the sample was diagnosed positive for OSA (AHI of ≥ 5). The final model included 2 BFRSS screening questions, 1 Promis question, and 1 question from the ESS. After controlling for potential confounders, the odds ratio for the final model was 1.766 (95% confidence interval = 1.12-2.78).

Conclusion: Screening for OSA is a complicated process that involves the assessment of several variables. The variables included in our proposed predictive model are important indicator variables of individuals at high risk for positive diagnosis of OSA on PSG testing.

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0383

QUANTIFYING THE UNDERESTIMATION AND UNDERREPRESENTATION OF OBSTRUCTIVE SLEEP APNEA SEVERITY BY HOME SLEEP TESTING; USING CALCULATED APNEA-HYPOPNEA INDEX FROM IN-LAB POLYSOMNOGRAPHY

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Introduction: Obstructive sleep apnea (OSA) affects 2-4% of adults and is commonly under-diagnosed. Untreated moderate-severe OSA is associated with higher cardiovascular risks. In-lab polysomnography (PSG) is a gold standard diagnostic test but home sleep testing (HST) is increasing due to economical reasons. Most HST utilizes total recording time (TRT) instead of total sleep time (TST) with potential to underestimate OSA severity. Purpose of this study is to quantify the underestimation of OSA severity based on apnea-hypopnea Index (AHI), by calculating a hypothetical AHI_{HST} (using TRT instead of TST and comparing that to actual AHI) and develop measures to improve clinical judgment in utilizing HST.

Methods: Retrospective analysis of adult patients who underwent PSG in 2011. Paired t-test was used to assess mean AHI difference in mild, moderate and severe OSA. Additionally, underrepresentation in each category was also calculated.

Results: Out of 1294 PSGs, 333 studies were included. Mean age was 48.5 \pm 14.2, mean BMI was 34.5 \pm 8.39 and females represented 60% of our population. There were 168, 88 and 77 patients in mild, moderate and severe OSA categories respectively and 22.6%, 42% and 50.1% were underrepresented in their respective severity. There was a significant difference in means of AHI and AHI_{HST} in mild ($M_{AHI} = 9.5 \pm 3.1$)

($M_{HST} = 7.4 \pm 2.9$); $t(167) = 14.5$, $p < .001$, moderate ($M_{AHI} = 21.5 \pm 4.5$) ($M_{HST} = 16.1 \pm 4.2$); $t(87) = 13.1$, $p < .001$, and severe disease ($M_{AHI} = 55.7 \pm 26.2$) ($M_{HST} = 33.7 \pm 16.2$); $t(76) = 9.3$, $p < .001$. Sensitivity to diagnose moderate-severe disease ($AHI > 15$) was increased from 73% to 89% when AHI_{HST} cutoff was reduced to $AHI > 12$.

Conclusion: Although PSGs in this study are in-lab and not home setting, AHI_{HST} can be considered a good surrogate of HST. This study elucidates the significant underestimation of AHI and underrepresentation of severity of OSA by HST. Selecting an AHI cutoff of 12, will significantly reduce the number of undertreated moderate-severe OSA by HST.

0384

A COMPARISON OF ACCEPTED OBJECTIVE MEASUREMENTS FOR SNORE ANALYSIS BY THE AMERICAN ACADEMY OF SLEEP MEDICINE

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Introduction: Snoring, independent of sleep apnea has been reported to have serious health consequences including carotid atherosclerosis. Detection of snoring is currently dependent on limited, poorly defined methods. Our study aims to add knowledge on how to objectively measure snoring by comparing the three methods currently recommended by the American Academy of Sleep Medicine.

Methods: 10 subjects (5 males, 5 females) reporting habitual snoring were included in the study. Subjects were assessed with in-laboratory polysomnography. Snoring was assessed with two overhead microphones, one chest microphone, a neck piezoelectric vibration sensor and nasal pressure transducer (cannula).

Results: For a given snore event, a high correlation was found between sound power of the chest microphone and the average sound power of the two overhead microphones. The fundamental frequency of snore events was measured from 50-444 Hz by sound analysis. However, the cannula and piezoelectric sensor could only measure a range from 0-100 Hz. 67.9% of snore events had a fundamental frequency above 100 Hz. The cannula also had a high noise floor, masking an additional 9.7% of the snore events. The piezoelectric sensor was sensitive to postural effects, causing the strength of the snore signal to increase when the subject was lying or the side of the sensor.

Conclusion: Sound measurement of snoring, on the patient chest or overhead, was found to be the most accurate objective assessment of snoring. Current methods of nasal cannula and neck piezoelectric measurements miss out on a significant portion of snore events.

Support (If Any): This study was supported by the Landspítali University Hospital Science Fund (A-2013-032) and the ResMed Foundation, California, United States.

0385

BREATHING SOUNDS' SPECTRAL AND HIGHER ORDER STATISTICS CHANGE SIGNIFICANTLY FROM WAKEFULNESS TO SLEEP IN PEOPLE WITH SEVERE OBSTRUCTIVE SLEEPAPNEA

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Introduction: Breathing sounds analysis provides valuable information for diagnosis of obstructive sleep apnea (OSA) even during wakefulness. In this study, we investigated whether the breathings sounds' higher order statistics characteristics (HOS) change from wakefulness to sleep,

and more importantly whether this change is associated with severity of OSA.

Methods: Tracheal breathing sounds were recorded from patients simultaneously with full night polysomnography (PSG) assessment. We selected data from two groups of patients: those whose Apnea/Hypopnea index (AHI) was less than 5 (called non-OSA) (6 individuals, 50 ± 15.2 y) and those with an $AHI > 30$ (6 individuals, 55.7 ± 10.3 y). In order to reduce variability, we selected sleep data of the patients who had data during stage 2 of sleep in supine position (as that was the most common position among patients). Wakefulness data were extracted from the first few minutes that the same patient, while they were awake and in supine position. From each wakefulness and sleep data, 5 respiratory cycles breathing sounds were extracted and sequestered into inspiratory and expiratory segments. After normalizing each segment to its energy, spectral and HOS features were calculated. We also ran a t-test to investigate which features changed most significantly from wakefulness to sleep.

Results: Several features, such as the median bispectral frequency, crest factor, and spectral centroid were found to change significantly from wakefulness to sleep mostly in severe OSA group but not as much in non-OSA group. The most prominent change between the two groups of patients was observed in median bi-spectral frequency: it changed significantly from wakefulness to sleep in people with severe OSA and not as much in non-OSA group.

Conclusion: Given that imaging studies have shown the upper airway narrows and become more collapsible in people with severe OSA, implies that the flow of air in their airway becomes turbulent; the air turbulence in a non-homogenous tube such as airway in particular in the presence of OSA, causes the vibration picked up on the surface of trachea (breathing sounds) to have more than one mode of frequency oscillation; this is a characteristic that bi-spectral analysis can show.

Support (If Any): This study was supported by National Science and Engineering Research Council (NSERC) of Canada.

0386

WHO IS GETTING PORTABLE RECORDING FOR OSA? TEST RESULTS ON 200,421 PATIENTS

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Introduction: Obstructive sleep apnea syndrome (OSA) is a serious medical condition associated with increased morbidity, mortality, and high direct and indirect costs. Unattended portable recording (PR) is rapidly becoming a more common diagnostic pathway for OSA. We present here a descriptive overview of the largest-to-date clinical sample of patients being tested for OSA by a PR system.

Methods: The Apnea Risk Evaluation System (ARES) includes a forehead-worn PR device that simultaneously records airflow, oxygen, pulse rate, snoring, and head position/movement for off-line analysis and review. ARES data were obtained from adult patients (18-90 yr) tested between January 2009 and October 2013 in North America. Full-disclosure recordings were scored and interpreted as per a standard protocol and the presence of OSA was defined using an $AHI \geq 5$ and $RDI \geq 15$. Data on self-reported health conditions as documented in the risk questionnaire are also presented.

Results: The sample was predominantly male (59%), middle-aged (53.5 ± 14.2 yr), obese (31.3 ± 5.7 kg/m²) with a large neck circumference (Males = 16.9 ± 1.2 in; Females = 15.0 ± 1.3 in) and a mild degree of sleepiness (ESS of 8.7 ± 5.3). Mean number of study nights was $1.3 \pm .5$ and mean recording duration was 6.2 ± 1.4 hours with a mean valid sleep time of 5.3 ± 1.4 hours. Mean AHI and RDI was 17.0 ± 17.8 and 27.4 ± 19.5 events/hr. Mean oxyhemoglobin saturation and heart rate

was $94.5\% \pm 2.0\%$ and 68.2 ± 10.0 BPM, respectively. The vast majority of patients (75.9% & 69.7%) were diagnosed with OSA based on AHI ≥ 5 and RDI ≥ 15 , respectively. The most common self-reported medical comorbidities were hypertension (46.8%), depression (25.4%), and diabetes (16.6%).

Conclusion: These data are the first of its kind to describe basic demographic and diagnostic test outcomes in a large sample of patients being tested with a PR. These findings confirm that the majority of individuals being home tested for OSA are obese, sleepy, males with a moderate degree of OSA based on PR and a high likelihood of hypertension.

0387

THE EFFECT OF ZOLPIDEM CR ON SLEEP AND NOCTURNAL VENTILATION IN PATIENTS WITH HEART FAILURE AND ISCHEMIC HEART DISEASE

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Introduction: Cardiovascular diseases are leading cause of death, among them heart failure (HF). Patients with HF usually complain of insomnia and present sleep-disordered breathing. We sought to evaluate the effect of zolpidem CR 12.5 mg on sleep and nocturnal breathing in patients with HF secondary to ischemic heart disease in a double-blind placebo-controlled crossover study.

Methods: Fifteen patients with ischemic cardiac disease, ejection fraction $\leq 45\%$, and with functional class 1 and 2 NYHA were included in this study. We excluded patients who were taking sedative-hypnotic medications in the last month with major medical disease and creatinine levels ≥ 1.3 mg/dL. All patients were under standard HF protocol treatment. Patients underwent 3 full polysomnographic recordings: 1-baseline; 2 and 3- with zolpidem CR 12.5 mg or placebo. Sleep questionnaires, clinical socio-demographic parameters, as well as echocardiographic data were obtained for all patients. We also measured patients' neck circumference before bedtime and before leaving the bed the morning after.

Results: Total Sleep Time and percentage of N3 were significantly higher in zolpidem CR night ($p = 0.01$, both). There was a significant increase in obstructive apnea index in zolpidem CR condition ($p = 0.01$), but no differences were found in central apneas, AHI, and RDI compared with placebo. Minimal SaO₂ was significantly lower in zolpidem CR condition ($p = 0.002$), but no differences were found in time of SaO₂ $< 90\%$ or mean SaO₂ during sleep.

Conclusion: Zolpidem CR improved sleep, which potentially benefits cardiovascular status, but it increased the obstructive component of apneas without affecting total AHI or central apneas. We evaluated a single night of treatment; studies addressing long-term use of Z drugs in this population are needed.

Support (If Any): AFIP (Associação Fundo de Incentivo à Pesquisa) and CNPQ (Conselho Nacional de Desenvolvimento Científico e Tecnológico).

0388

MORE ACCURATE BEDSIDE PREDICTION OF PRESENCE AND SEVERITY OF SLEEP APNEA BEFORE POLYSOMNOGRAPHY, QUALITATIVE AND QUANTITATIVE SCORING

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Introduction: Obstructive sleep apnea-hypopnea (OSAH) increases the risk for cardiovascular diseases, cancers and vehicular accidents. Physi-

cians often miss signs and symptoms of OSAH, thus large number of undiagnosed patients remain at great risks. Stanford Sleepiness Scale (SSS) and the Epworth Sleepiness Scale (ESS), Berlin Questionnaire (BQ) were found to have a low level of sensitivity and specificity for prediction of OSAH; thus a more accurate methodology is needed to predict the presence and severity of OSAH at the bedside using qualitative and quantitative variables, weed out unnecessary referral of low probability OSAH and expedite referrals to sleep medicine specialists for those at high probability for OSAH.

Methods: Simplified weighted variables age, snoring, body mass index (BMI), ESS, and Mallampati classification (MC). ChanScore (0 to 10) is the sum of the weighted values that corresponds to each variable. Retrospective analyses of 315 patients (M/F - 175:140), were prospectively correlated to 52 subjects' (M/F - 33:19) individual variables to optimize its weighting. Ordinal regression analyses were executed using AHI-categories as defined: 1) AHI < 5 , 2) AHI 5-14.99, 3) AHI 15- 29.99, 4) AHI 30-49.99, 5) AHI ≥ 50 .

Results: Age, snoring, BMI, ESS, and MC when analyzed individually proved to have lesser statistical significance in ordinal regression using AHI-Categories (Age: p -value $< .00001$, Snoring: p -value .02, BMI: p -value $< .00001$, ESS: p -value .10, MC: p -value .007) than the multilateral score (p -value $< .0000000001$) which accurately diagnosed over 80% of the population's OSAH (AHI ≥ 5 threshold for OSAH as defined by the American Academy of Sleep Medicine) at the bedside before polysomnography (PSG)

Conclusion: Our weighted scoring (0 to 10) predicts the presence and severity of OSAH at the bedside and correlated well with PSG. It is a simple clinical tool for physicians, who may have no training in sleep medicine, to quickly identify patients who may have OSAH and predict its severity.

0389

EVALUATION OF MICRO SLEEP ARCHITECTURE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA BEFORE AND DURING CPAP TREATMENT

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Introduction: Conventional sleep scoring evaluates Macro-Sleep Architecture (MSA) by several parameters (total sleep time (TST), sleep efficiency (SE), sleep-stage distribution, Arousal/Awakenings Index (AI)). These parameters are difficult to combine into a unitary index of sleep quality. The Odds Ratio Product (ORP) is a new automatic index that estimates the prevalence of awake-like intrusions during sleep. It is calculated from spectral analysis of the EEG in 3-second intervals. ORP ranges from 0 (stable sleep, uninterrupted by awake patterns) to 2.5 (fully awake). This study was undertaken to determine whether ORP reflects the expected improvement in sleep quality following application of CPAP in severe obstructive apnea (OSA) patients.

Methods: Thirty-eight patients (24M/14F) with severe OSA (AHI 43 ± 32 hr⁻¹) underwent a split study. TST, SE, % of sleep in different stages, and AI were determined by conventional criteria before and during application of therapeutic levels of CPAP. Average ORPs in different stages before and during CPAP were determined by an automatic scoring system.

Results: ORP values before CPAP were: TST: 1.05 ± 0.31 , N1: 1.38 ± 0.29 , N2: 0.95 ± 0.35 , N3: 0.76 ± 0.48 , REM: 1.34 ± 0.35 . These values compare poorly with values observed in subjects with no sleep pathology (ORP-TST: 0.53 ± 0.17). During CPAP, AHI decreased (5.3 vs. 43, $p < 0.0001$), SE increased (69 vs. 64%, $p < 0.05$), Stage nonREM-1 decreased (15 vs. 27% TST, $p < 0.0001$), stage REM increased (22 vs. 8% TST, $p < 0.0001$), and AI decreased (22 vs. 48 hr⁻¹). As % of TST, stages non-REM 2 and 3 did not change but ORP in these two stages

improved significantly (ORP-N2: 0.85, ORP-N3: 0.60, $p < 0.05$). REM-ORP also improved (1.20 vs. 1.33, $p < 0.05$). By multiple regression analysis, improvement in ORP-TST (0.96 vs. 1.05, $p < 0.05$) correlated significantly with the reduction in arousal index but not with reduction in AHI.

Conclusion: The improvement of ORP with CPAP supports the use of this index as a global measure of sleep quality.

0390

CORRELATION OF SPECTRAL AND BISPECTRAL TRACHEAL BREATH SOUND FEATURES WITH APNEA-HYPOPNEA INDEX DURING WAKEFULNESS

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Introduction: The current method of diagnosing obstructive sleep apnea (OSA) is time-consuming and costly. Breathing sounds recorded during wakefulness may contain diagnostic information to screen patients for OSA severity. In this study, correlations of spectral and bi-spectral features of breath sounds were examined in relation to apnea-hypopnea index (AHI).

Methods: Tracheal breathing sounds of 80 adult subjects were recorded during wakefulness in four configurations: nose and mouth deep breathing in both upright and supine postures before undergoing overnight polysomnography (PSG) at a local sleep clinic; subjects' AHI were collected prospectively. 40 subjects were non-OSA with an AHI30 (51 ± 11 y). Power spectral and bispectral features representing frequency distribution of the tracheal breathing sounds were computed from the upper 40% (of airflow) of each respiratory cycle. The difference in feature values between nose and mouth breathing as well as breathing in supine and upright positions were also calculated. Correlation coefficients between each feature and AHI value as well as statistical significance p -values for the null hypothesis (no correlation) were computed. All significantly different ($P < 0.05$) features between OSA and non-OSA subjects were ranked according to their correlation with AHI.

Results: We found 24 spectral and bi-spectral features with a moderate but significant ($P < 0.001$) correlation with AHI and an absolute correlation coefficient $|r|$ between 0.3 and 0.5. The mean spectral centroid between 600 and 1200 Hz of the sound of subjects' inspirations through the mouth in upright position had the highest $|r|$ of 0.46.

Conclusion: Breathing sounds recorded during wakefulness seem to contain information to screen patients prior to PSG. Examination of the influence of confounding variables, however, such as age and gender on breathing sound features, is required to determine how much of the correlation is due to OSA.

Support (If Any): This study was supported in part by National Science and Engineering Research Council (NSERC) of Canada and also by Philips.

0391

EVALUATION OF PRE-TEST RISK AND TEST OUTCOMES USING A PORTABLE RECORDING SYSTEM

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Introduction: Unattended portable recording (PR) is recommended as an alternative to traditional in-lab testing for patients with a high pretest probability of moderate to severe OSA. Despite this recommendation, little has been done to examine the relationship between OSA risk and subsequent outcome using PR. We present here diagnostic test outcome data from the largest-to-date clinical sample of individuals being tested for OSA via PR to (1) assess sample characteristics and (2) quantify test

results based on OSA risk as predicted by a pre-test OSA risk questionnaire.

Methods: The ARES PR device simultaneously records airflow, oxygen saturation, pulse rate, snoring, and head position/movement. Software integrates a screening questionnaire which quantifies OSA risk (none, low, high), and severity (none, mild, moderate, severe) based on typical symptoms of OSA, anthropomorphic indices, and common comorbid medical conditions. Data were obtained from 200,421 North American adult patients (18-90 yr) tested between January 2009 and October 2013. The presence of OSA was defined using standard apnea hypopnea index (AHI) and respiratory disturbance index (RDI) cut-offs (AHI ≥ 5 and RDI ≥ 15 , respectively).

Results: The majority of patients (74.6%) were identified as having a High Risk for moderate to severe OSA. Of this group, 81.5% and 76.3% of patients had an AHI ≥ 5.0 ($M = 23.3 \pm 18.8$ events/hr) and RDI ≥ 15.0 ($M = 36.9 \pm 18.7$ events/hr), respectively. Approximately 3.3% of the sample was identified as having No Apparent Risk of OSA. Of this group, 41.9% ($M = 13.4 \pm 11.7$ events/hr) and 32.7% ($M = 26.8 \pm 13.4$ events/hr) had an AHI ≥ 5.0 and RDI ≥ 15.0 , respectively.

Conclusion: Clinical evaluation and follow-up by providers appropriately-trained in sleep medicine is paramount since screening indices for pre-test risk are not always predictive of outcome or severity. Additional analyses of pre-test risk factors are needed to enhance predictive accuracy of current/future screening measures for OSA.

0392

SCREENING FOR OBSTRUCTIVE SLEEP APNEA VIA HIGH-FREQUENCY, QUANTITATIVE OXIMETRY SPECTRAL ANALYSIS

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Introduction: It is estimated that up to 80% of individuals with moderate or severe obstructive sleep apnea (OSA) remain undiagnosed. Although formal diagnosis of OSA requires polysomnography, investigators have turned to spectral analysis of oximetry data as a screening tool. Two previous studies demonstrated that a peak in the power spectral density (PSD) period range 30-70 seconds (P30-70 peak) is associated with OSA. These studies collected data at low frequencies (0.2 Hz) and evaluated peaks via subjective methods. We screened for OSA using nocturnal oximetry spectral analysis with oxygen saturation levels collected at high frequencies and PSD peaks measured via quantitative criteria.

Methods: Oximetry curves of twenty patients were reviewed from polysomnography studies. Ten patients had been diagnosed with OSA and ten patients had been ruled out for OSA using an apnea-hypopnea index (AHI) of < 10 . Each patient was evaluated over six hours at a frequency of 200 Hz. A fast Fourier Transformation was performed on the oximetry data to create a PSD for each patient. Each PSD was reviewed for the presence of the P30-70 peak, using an amplitude threshold corresponding to a power ≥ 50 percent squared.

Results: The presence of the P30-70 peak was 90% sensitive and 80% specific for OSA. Additionally, the presence of the P30-70 peak had a positive predictive value of 82% and a negative predictive value of 89%. None of the patients with AHIs < 5 or ≥ 20 were misdiagnosed via this method.

Conclusion: The presence of a P30-70 peak in an oximetry PSD was a strong predictor of OSA compared to AHI generated by polysomnography. Collecting oximetry data at high frequencies and using a quantitative measure of the P30-70 peak increased the sensitivity over one previous study and approximated the specificity of both prior investigations. Oximetry power spectral analysis performed in this manner could be useful in screening for OSA.

0393

A NEW TECHNIQUE OF VIRTUAL MODELING OF INDIVIDUAL PATIENT AIRWAYS IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Up to 14% of the U.S. population is estimated to have obstructive sleep apnea (OSA), with increasing incidence occurring in other countries as well, related to obesity. Other than continuous positive airway pressure, treatments have had variable results since the exact site(s) of obstruction and the optimal method of modifying those sites with devices or surgery can be difficult to establish. We introduce a technique for modeling the upper airway that shows the behavior of the airway and predicts the location of collapse in OSA.

Methods: The first step in accurately modeling the airway is to understand the viscoelastic properties of the pharyngeal walls, tongue, and palate, which have not been previously well characterized. This was done using 5 fresh porcine cadaver heads with a Bose ElectroForce test instrument with Dynamic Mechanical Analysis software. Various dynamic displacements were applied to tissue samples and associated forces measured simultaneously to obtain dynamic material properties. The next step in airway modeling is to relate these viscoelastic properties to human anatomy, which was done using ANSYS software applied to a 3-dimensional rendering of an OSA patient's airway (with an AHI of 87.6/hr) using thin-cut computed tomographic scan data.

Results: Areas of lowest pressure during inspiration were identified as likely regions of collapse during apneic episodes, such as the base of the tongue with pressures as low as -4730 Pa (-48.23 cm H₂O), similar to values reported in human esophageal pressure measurements in upper airway resistance syndrome.

Conclusion: This novel investigation virtually and accurately models the upper airway in OSA, and allows virtual modification of the airway to predict effects of treatment.

0394

HISPANIC ETHNICITY AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is the most common sleep related breathing disorder. Characteristics of affected populations are not well understood. Gender, body mass index (BMI), craniofacial structure, adipose tissue distribution, and ethnicity/race have been associated with OSA. We sought to determine if Hispanics have severe OSA than non-Hispanic whites

Methods: Data from 467 consecutive adult patients (116 Hispanic and 351 non-Hispanic white) with apnea hypopnea index (AHI) > 5 assessed on in-lab polysomnography were analyzed. The sample included 296 male and 171 female patients ranging in age from 18-90 years.

Results: As expected, the mean AHI of males is significantly higher than females (27.1 versus 21.5, respectively; $p = .006$). Among male patients, 72 were Hispanic and 224 were non-Hispanic white. The mean AHI of Hispanic males is significantly higher than non-Hispanic white males (Hispanic male = 32.6, non-Hispanic white male = 25.4; $p = .018$). To control for the influence of obesity, the AHI scores were stratified by BMI. The difference in AHI between Hispanic and non-Hispanic white males is pronounced at WHO obesity classes II and III. Hispanic males have significantly higher mean AHI compared with non-Hispanic white males at BMI range 35-40 (Hispanic males = 48.6, non-Hispanic white

males = 29.1; $p = .008$), and BMI > 40 (Hispanic males = 47.0, non-Hispanic white males = 28.7; $p = .02$). No difference in the severity of OSA was found between Hispanic and non-Hispanic white females.

Conclusion: Hispanic ethnicity is associated with increased severity of OSA. Obese Hispanic males show a propensity to develop severe OSA compared with non-Hispanic white males. Craniofacial anatomy and smooth muscle tone in the respiratory tract may be contributing factors. Further research with larger samples is needed to better understand the role of ethnicity in OSA

0395

ARE THERE MORE SLEEP PROBLEMS IN A HISPANIC POPULATION? AN ASSESSMENT IN A CLINICAL SLEEP POPULATION

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Introduction: Despite Hispanics being the most rapidly growing ethnicity group in the US, there continues to be a paucity of data related to sleep characteristics and problems in this population. Some subjective reports have suggested a higher incidence of snoring and sleep apnea in this population, but little to no objective data to support. The current study assesses preliminary data investigating sleep problems in Hispanics.

Methods: A total of 237 patients who presented to a South Texas sleep center for diagnostic PSG were included in this retrospective database analysis. As part of their visit, patients completed a sleep and medical history questionnaire. Inclusion criteria were 18-79 year old Hispanics (H) or non-Hispanic Whites (NH) with no prior sleep disorder evaluation.

Results: In comparison to the NH group, the H group had a significantly higher incidence of obesity (73% vs. 42%; $p < .001$), HTN (61% vs. 46%; $p < .05$), and diabetes (46% vs. 13%; $p < .001$). The H reports less sleep time in general than NH, but significantly less on weekends (7.1 hr vs. 7.8 hr; $p < .05$). There were no significant differences in relation to subjective sleep latency or sleep awakenings. PSG results revealed the H group had a significantly higher AHI than the NH group (43.4/hr vs. 30.7/hr; $p < .01$), lower SaO₂ nadir (80% vs. 83%; $p < .05$), and less Stage N3 sleep ($p < .05$). There were no differences in other PSG parameters.

Conclusion: Hispanics, on average, had a higher incidence of sleep disordered breathing as well as higher rates of key co-morbid factors. Although the population is skewed to a clinical population, it is clear additional work is needed to fully understand the significance of sleep disorders and sleep habits in a Hispanic population to ensure proper evaluation and treatment is performed.

0396

MILD OBSTRUCTIVE SLEEP APNEA: A TRUE CLINICAL DISEASE?

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Introduction: The impact caused by moderate and severe OSAS is well defined in scientific literature. However, the consequences of such disease in its milder form are still unknown. Objective: To evaluate the effects of mild OSAS over subjective and objective somnolence, quality of life, mood, cognition, sexual function and cardiovascular, cognitive and hormonal parameters.

Methods: 64 volunteers were included in this study. Both genders, body mass index ≤ 35 kg/m², 18 to 65 years old. The Mild OSAS group

(OSAS) included patients with apnea-hypopnea index $5 \geq (\text{AHI}) \leq 15$, ($n = 39$). The Control group (GC) included subjects with $\text{AHI} < 5$, respiratory disturbance index (RDI) ≤ 5 , arousal index ≤ 15 and Epworth Sleepiness Scale (ESS) ≤ 9 , ($n = 25$). Both groups underwent full night polysomnography and the Maintenance of Wakefulness Test (MWT). In addition subjective assessment of mood (Anxiety and Depression Beck Inventory), ESS, Functional Outcomes of Sleep Questionnaire (FOSQ), Modified Impact Fatigue Scale (MIFS), sexual function, blood tests, Ambulatory Blood Pressure Monitoring (MAPA), Peripheral Arterial Tone (EndoPAT) and Performance Vigilance Test (PVT) were also performed. This study was approved by UNIFESP Research Ethics Committee, CEP n° 1300/11 and Clinical Trials: NCT01461486.

Results: In the OSAS: ($\text{AHI}: 9.0 \pm 2.8$, $\text{BMI}: 28.88 \pm 3.91 \text{ kg/m}^2$, age: 48 ± 9) and GC: ($\text{AHI}: 1.3 \pm 1.1$, $\text{BMI}: 24.17 \pm 3.07 \text{ kg/m}^2$, age: 36 ± 9). The results were controlled by age and BMI. Compared to the Control group, mild OSAS demonstrated significant increase in: mean daytime systolic pressure (124 ± 12 and 117 ± 13 , $p = 0.04$), mean morning systolic pressure (119 ± 16 and 108 ± 15 , $p = 0.03$), mean morning diastolic pressure (75 ± 14 and 67 ± 12 , $p = 0.02$), and arterial stiffness adjusted (7.58 ± 17.94 and 1.36 ± 18.78 , $p = 0.05$), ESS score (11 ± 8 and 6 ± 10 , $p = 0.01$, cognitive domain of MFIS (18.98 ± 14.36 and 12.26 ± 19.16 , $p = 0.05$) and lapses (3.90 ± 4.16 and 2.43 ± 5.55 , $p = 0.004$). The other parameters analyzed did not differ between groups.

Conclusion: Patients with mild OSAS had higher arterial pressure, arterial stiffness adjusted, lapses, are more sleepy and fatigued when compared with normal subjects.

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0397

EFFECT OF SLEEP DISORDERED BREATHING ON ACADEMIC ACHIEVEMENT IN MEDICAL STUDENTS

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Introduction: Sleep-disordered breathing (SDB) is known to cause excessive daytime sleepiness and has been shown to cause poor academic performance in young children. The present study aimed to determine whether SDB influences examination results in medical students.

Methods: Participants included 94 fifth-year medical students. All students were instructed to wear a monitoring device overnight at home. The device was retrieved the next day and data were visually analyzed. Examinations used for the assessment of academic achievement were multiple-choice tests about medical and public health knowledge essential for physicians. They were composed of general questions, clinical questions, and compulsory questions.

Results: Odds ratios (OR) of SDB for poor achievement by each question type were 3.72 (95% confidence interval [CI], 1.19-11.63; $P = 0.05$) for general questions, 9.18 (95% CI, 0.98-86.0; $P = 0.07$) for clinical questions, and 3.85 (95% CI, 0.85-17.3; $P = 0.14$) for essential questions.

Conclusion: The results of this study suggest that SDB may adversely affect medical student achievement as measured by general questions, in which declarative memory is involved.

0398

REM SLEEP RELATED BREATHING DISORDER DEMOGRAPHICS AND CLINICAL FEATURES

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Introduction: REM sleep related breathing disorder is an emerging entity with unique clinical features. Understanding the clinical features of this disorder is important to outline effective management strategies.

Methods: A retrospective chart review was performed at University of Missouri, Columbia sleep center on baseline polysomnograms of patients with REM related breathing disorders. Inclusion criteria: 1. Patients with REM apnea-hypopnea index (AHI) more than 5. 2. REM AHI at least 2 times Non REM AHI.

Results: 230 patients met criteria. There were a total of 68 males (29.5%) and 162 females (70.5%). Mean age was 48.7 years (range: 24-80) and mean body mass index was 38.9 (18-80). Mean AHI was 9.62 (0.4-44), mean REM AHI was 35.19 (5.2-100.3) and non REM AHI was 5.34 (0-38.14.7). The most common complaints were snoring, excessive daytime somnolence, apneas and fatigue.

Conclusion: Our study suggests that a higher proportion of females have REM related breathing disorder. There were no differences in age between males and females. We postulate that estrogen may be a protective factor against REM related breathing disorders as women with REM related breathing disorder tend to be in peri- or post-menopausal age. REM related breathing disorder occurs with mild disease in obese patients. REM related breathing disorder has night to night variability. As such, it is important to extend total recording time especially in latter part of the night when REM sleep tends to be longer and more consolidated. REM sleep is associated with more severe and prolonged respiratory events with significant hypoxemia and respiratory event related autonomic instability. This study demonstrates that REM AHI and amount of REM sleep obtained, degree of hypoxemia, and duration of REM related respiratory events during are important factors to consider in making treatment decision.

0399

PATIENTS PERCEIVED SOURCE OF SLEEP APNEA EDUCATION

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Introduction: The treatment of obstructive sleep apnea is unique in that patient care is often provided by multiple entities. The purpose of this study was to examine who patients believed was most helpful in providing education regarding obstructive sleep apnea (OSA) and the use of positive airway pressure (PAP), and, whether the source of this information affected successful treatment.

Methods: Adult individuals, age 18 and older, with a diagnosis of OSA and receiving PAP therapy were invited to voluntarily participate in an anonymous survey. Recruitment occurred over a consecutive 365 day period from March 2010 to March 2011.

Results: A total of 898 patients participated. 53% of study subjects were male, 38% were female and 9% did not disclose their gender. Half of all participants reported that sleep medicine physicians were their primary source of education regarding obstructive sleep apnea. The remaining 50% identified family members, friends, durable medical equipment (DME) personnel and sleep technologists. Individuals who achieved successful PAP use in < 1 month (defined as > 4 hours nightly use) were more likely to report obtaining OSA information from a sleep technologist than from another source ($p = 0.04$). Thirty six percent of patients

viewed physicians as their primary source of education regarding positive airway pressure use and 64% identified a non-physician source (16% family/friends, 22% sleep technologists and 26% DME personnel). Those who achieved successful PAP use in < 1 month were more likely to report obtaining PAP information from durable medical equipment personnel than from another source ($p = 0.04$).

Conclusion: It is clear that patients with a diagnosis of OSA receive education regarding their disease and its treatment from many sources other than sleep medicine physicians. It appears that both sleep technicians and DME personnel play a significant role in successful PAP use.

0400

DO PATIENTS PRESENTING TO THE ED HAVE A HIGHER PREVALENCE OF UNDIAGNOSED OSA?

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Introduction: Obstructive sleep apnea (OSA) is associated with an increased risk of cardiovascular complications including CAD, CHF, arrhythmias, TIA, and stroke as well as headaches, depression, and suicide. Early recognition of OSA and appropriate management may reduce complications and improve outcomes. Prior studies have estimated the prevalence of OSA syndrome as 5-9% in the general population. We estimated the probable prevalence of OSA in patients presenting to the ED.

Methods: We performed a prospective observational study of a convenience sample of adult ED patients presenting to a large, academic medical center. Unstable patients and those with a history of OSA were excluded. Standardized data collection included demographic and clinical information as well BMI and neck circumference. Patients were administered a Berlin questionnaire (those with medical complaints) or a STOP BANG questionnaire (for those with surgical complaints), both of which have been validated to screen for the presence of OSA. Patients screening positive in either questionnaire were considered at high risk of OSA. The point prevalence of high risk for OSA was calculated with 9% confidence intervals (CI). Univariate and multi-variate analyses were performed to determine the association between patient characteristics and high risk of OSA.

Results: A total of 275 patients met the inclusion criteria and were screened. Mean age was 46 yrs; 56% were female. Presenting complaints included chest pain (34), abdominal pain (90), infections (41), musculoskeletal injury (52), anxiety (40), palpitations (10), nausea/vomiting (15), SOB (22), CHF (4), Headache (10), substance abuse (3), or other (87). Of all patients 130 (46.5%) were at high risk for OSA (95% CI, 40.7-52.4). Factors associated with high risk for OSA on multivariate analysis included age (OR 1.02 for every additional year), and neck circumference (OR 1.15 for each additional cm). The rate of non-hypertensive cardiovascular disease in patients who screened positive for OSA was higher than in those who did not (33.8% vs. 15.9%; difference 18.0% [95% CI, 7.7-27.9]). High risk for OSA was not associated with respiratory, metabolic or psychiatric disease.

Conclusion: Based on validated surveys, the estimated prevalence of OSA in ED patients with medical and surgical complaints is 43% and 59% respectively, much higher than previous estimates in the general population. Emergency physicians should consider screening and referring patients for OSA.

0401

PREDICTORS OF SLOW-WAVE ACTIVITY IN OVERWEIGHT AND OBESE ADULTS: ROLES OF SEX, OBSTRUCTIVE SLEEP APNEA AND TESTOSTERONE

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Introduction: Two-thirds of the US population is now overweight or obese. While sex and age have been identified as predictors of the large inter-individual differences in slow-wave activity (SWA), a stable within-subject characteristic, previous studies have been performed mainly in lean individuals. The aim of the study was to identify predictors of SWA in overweight and obese adults.

Methods: Hundred and one overweight and obese subjects recruited from the community (44 men, 57 women, aged 20-50 years) underwent an overnight in-laboratory polysomnogram. SWA was computed as the average absolute spectral EEG power in the frequency band 0.75-4.5 Hz during NREM sleep, in the first 6 hours of sleep. Obstructive sleep apnea (OSA) was defined by an apnea-hypopnea index (AHI) ≥ 5 . Multivariate regression models were run in all subjects and separately in men and women to explore the predictors of SWA, after adjusting for age, BMI and ethnicity.

Results: After adjustment, the odds ratio for OSA in men, compared to women, was 3.71 ($p = 0.03$). A significant sex \times AHI interaction for SWA was observed in a regression model including all subjects ($p = 0.001$). This reflected the fact that OSA was associated with a robust decrease in SWA in men (-34%; $p = 0.007$) but not in women. In sex-specific models, African-American race negatively predicted SWA in both sexes (men: $\beta = -0.26$, $p < 0.001$; women $\beta = -0.21$, $p = 0.002$). Age was a significant negative predictor of SWA in women ($\beta = -0.03$, $p = 0.008$), with a trend for significance in men ($\beta = -0.02$, $p = 0.08$). Finally, circulating testosterone was independently associated with decreasing SWA in men ($\beta = -0.56$, $p = 0.02$), but not in women.

Conclusion: OSA was associated with decreased SWA in men, but not in women. In men only, in addition to race, age and AHI, higher circulating testosterone levels predicted lower SWA. These results have potential clinical implications as prescriptions for exogenous testosterone have increased.

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0402

SNORING IN COLLEGE ATHLETES: IS THERE A RELATIONSHIP WITH THE WEIGHT?

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Introduction: Snoring in college students may be the earliest presentation of sleep-disordered breathing. Snoring prevalence among athletic college student is unknown. In addition, we could not find data regarding the effect of athletic BMI on snoring prevalence and snoring level.

Methods: A survey of athletic students from three local colleges was conducted. The database was reviewed for demographics, sport type, STOP-BANG questionnaire and other pertinent medical problems.

Results: 478 students were screened, of them 391 students had available "snoring" data. 117 (29.9%) females, 274 males played variable sports (included in the full analysis). Athletes mean age was 19.57 (1.84) with range of 17-31 years. Mean height was 69.93 (4.15) in, mean weight 168.09 (31.49) Lb and mean BMI was 23.61 (5.14). 114 (29.2%) students reported snoring. Snoring level ranged between "slight" snoring

(71.9% of snorers) to “very loud” snoring (1.8%). Nine students (2.3%) reported being diagnosed with HTN. Snorers had significantly higher BMI compared to non-snorers (24.74/ 5.19 vs. 23.17/5.05 $P = 0.008$). BMI also correlated significantly with snore levels reported between groups (combined sig = 0.04 and Linearity = 0.006).

Conclusion: In our college athletes’ population, we found significant correlation between BMI and snoring. Also, snoring level increased with higher BMI.

0403

RACIAL/ETHNIC DIFFERENCES IN SLEEP DISORDERED BREATHING IN NORMAL WEIGHT, OVERWEIGHT, AND OBESE ADULTS: THE MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS

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Introduction: Sleep disordered breathing (SDB) is associated with obesity and may vary across racial/ethnic groups. This study aimed to assess relations between body mass index (BMI) and SDB among White, Black, Hispanic, and Chinese Americans.

Methods: The samples were participants in the Multiethnic Study of Atherosclerosis who underwent polysomnography as part of Exam 5. Sleep Apnea Syndrome (SAS) was defined as an apnea-hypopnea index (AHI) ≥ 5 and sleepiness (Epworth Sleepiness Scale score > 10). Pearson correlation coefficients and multivariable linear and logistic regression procedures were used to assess associations of BMI with AHI and SAS, according to racial/ethnic background with adjustment for confounders.

Results: Of 1924 participants aged 54-93 years, 10% had SAS (Whites: 7.6%; Blacks: 13.1%; Hispanics: 9.9%; Chinese Americans: 10.4%). There were significant associations between BMI and AHI and SAS across racial/ethnic groups (partial r ranged 0.31-0.41, all $P < 0.001$). For a given BMI category, adjusted mean AHI was significantly higher for Chinese than others. Among lean participants (BMI < 25) and overweight (BMI = 25-29), Chinese had mean AHI scores that were 5.53 units higher (SE = 1.37, $P < 0.001$) and 5.70 (SE = 1.90, $P = 0.003$), respectively, than their lean White counterparts. Within BMI categories, AHI levels were similar for Hispanics and Blacks compared to Whites. The odds of SAS in relation to race/ethnicity varied across BMI categories. Among overweight individuals, Blacks (OR = 1.92, 95% CI = 0.93-3.97), Hispanics (OR = 1.73 (0.72-4.15)), and Chinese (OR = 3.18 (1.28-7.91)) had a higher age-adjusted odds of SAS than Whites. No similar associations were observed among lean individuals.

Conclusion: Age- and BMI-adjusted SAS prevalence estimates and mean AHI scores were the highest for Chinese Americans across BMI categories. Among overweight and obese individuals, SAS prevalence defined using AHI and sleepiness was higher in all minorities compared to Whites, possibly due to an increased prevalence of sleepiness in minority groups.

0404

FAILURE MODES OF ADAPTIVE SERVO VENTILATION IN THE CONTROL OF CENTRAL SLEEP APNEA

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Introduction: Adaptive servo-ventilation (ASV) is a recommended treatment for central sleep apnea (CSA). However, ASV failure (defined as AHI ≤ 10 /hour) has been noted in 19-34% patients with central/complex sleep apneas. The reasons for ASV failure are unknown.

Methods: We reviewed 500 ASV titration polysomnograms (PSGs) between January 2009 and October 2013. Focusing on CSA patients only, we identified 11 ASV failures in 10 patients (one patient underwent 2 ASV titrations). At the end expiratory pressure (EEP) that eliminated obstruction and minimized the AHI, each residual apnea/hypopnea was examined and assessed for failure modes: impedance problems (pressure delivery without leak and without air entry into chest), leaks, inadequate backup rate (ASV pause ≥ 7 sec), or insufficient pressure support to generate adequate tidal volume to eliminate hypoxia. We recorded the frequency of failure modes.

Results: The mean (range) diagnostic AHI was 56.6/h (13-135/h) and central apnea index of 41.6/h (12-104), age was 65.9 (28-90) years, and BMI was 30 (20.7-53.5) kg/m². Comorbidities included congestive heart failure (5), neurological disorders (2), renal failure (2), and chronic opioid use (2). The mean AHI at best EEP was 31.3/h. We identified 74 impedance problems, 13 leak issues, 3 inadequate backup rates, and 7 failures as a result of insufficient pressure support. Impedance problems were evident when EEP values on ASV were higher than the CPAP required to eliminate obstructive events.

Conclusion: Airway impedance is a major cause of ASV failure as it prevents the delivery of an ASV triggered breath. Complete active glottis closure has been previously described in CSA during ASV at the minimum EEP, but our work shows that this “reverse obstructive apnea” appears unresponsive to EEP, and may be the most common underlying cause for ASV failure. This tendency is individualistic and may arise from varied mechanisms.

0405

BIPAP WITH AVAPS SETTING AS A THERAPEUTIC OPTION IN COMPLEX SLEEP APNEA SYNDROME DUE TO RESTRICTIVE LUNG DISEASE SECONDARY TO LEVOSCOLIOSIS

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Introduction: Complex sleep apnea syndrome (ComSAS) is a distinct form of sleep related breathing disorder. It is defined as appearance and persistence of central apnea and hypopnea events, predominantly during NREM sleep, following the use of CPAP in patients with obstructive sleep apnea (OSA). Currently there were no therapeutic interventions that consistently helped ComSAS patients.

Methods: 44-year-old female with mild restrictive lung disease (FVC 77%, FEV1 76%, FEV1/FVC 84%) secondary to levoscoliosis presented with daytime sleepiness (EPSS 13), fatigue and choking spells during sleep. Apnea-Hypopnea Index on initial polysomnogram (PSG) was 136. On CPAP titration study, she exhibited 8 central apnea or hypopnea events per hour, predominantly during NREM sleep that was consistent with the diagnosis of ComSAS. She was started on bi-level positive airway pressure (BiPAP) of 12/7 cm of H2O with only partial response and persisting desaturations on the repeat PSG. She was then started on BiPAP of 12/7 with a backup rate of 10, and average volume assured pressure support (AVAPS) mode with a tidal volume of 400 ml,

along with a 3-liter supplemental oxygen. AVAPS setting dramatically reduced desaturations and improved her sleep apnea related symptoms.

Results: OSA patients with cardiovascular comorbidities, hypertension and opioid use are at increased risk of developing ComSAS. The occurrence of ComSAS in OSA patients with restrictive lung disease is not reported in the literature. The management of ComSAS is complex as one has to address both obstruction and ventilator dysfunction. BiPAP with AVAPS mode is a potential alternative in patients who failed isolated CPAP or BiPAP, as it utilizes a fixed tidal volume that automatically adjusts to patient's breathing requirements.

Conclusion: ComSAS is an uncommon but disabling sleep related breathing disorder seen in OSA patients. Current positive pressure ventilation treatment modalities had limited success in alleviating patient's symptoms and minimizing desaturations. BiPAP with AVAPS setting is a promising, novel form of positive airway pressure device that needs to be considered in patients with complex sleep apnea syndrome, who responds poorly to conventional CPAP or BiPAP.

0406

EMERGENCE OF COMPLEX SLEEP APNEA DURING CPAP AMONG CHINESE PATIENTS WITH OSAS

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Introduction: The aim of this study was to investigate the incidence of Complex sleep apnea syndrome (CompSAS) among Chinese patients with obstructive sleep apnea syndrome (OSAS) and compare the PSG features of OSAS and CompSAS patients during baseline and CPAP titration.

Methods: A retrospective review was undertaken based on the clinical and PSG records of 279 consecutive Chinese patients with a primary diagnosis of moderate or severe OSAS (AHI ≥ 15 /h), who received an over-night CPAP titration at the Sleep Medicine Center of West China Hospital from January 2010 to December 2012. Patients with central sleep apnea syndrome (central apnea index/CAI was ≥ 5 /h and central respiratory events comprised more than half of the respiratory events) at baseline were excluded. Patients were included in CompSAS group (N = 22) if CPAP titration largely eliminated obstructive sleep apnea events, but the residual CAI was ≥ 5 /h and central respiratory events comprised more than half of the residual respiratory events. The rest of them (N = 257) were included in OSAS group.

Results: The incidence of CompSAS was 7.9% (95%CI: 4.7%-11.1%). At baseline, CompSAS group had significantly higher AHI (67.1 vs. 62.1 /h), mixed apnea index (4.8 vs. 1.9 /h), arousal index (60.2 vs. 52 /h) and arousal index during NREM (41.6 vs. 35.3 /h) than OSAS group. During CPAP titration, compared to OSAS group, CompSAS group had statistically significant increases in CAI (8.2 vs. 0.8 /h), AHI (11.7 vs. 3.6 /h), AHI during NREM (14.6 vs. 4.0 /h), oxygen desaturation index (10.4 vs. 4.2 /h), oxygen desaturation index during NREM (12.2 vs. 4.6 /h), N1 stage (19.6 vs. 12.8%) and arousal index (25.6 vs. 17.6 /h).

Conclusion: CompSAS is not rare among Chinese patients with OSAS. After CPAP titration, CAI of CompSAS patients characteristically increases and most of the respiratory events occur in NREM sleep accompanied by oxygen desaturation. CompSAS patients have poor sleep quality and initial therapeutic effect during CPAP titration, suggesting that they need a close follow-up and reassessment to the efficacy of CPAP.

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0407

A NOVEL ADAPTIVE SERVO VENTILATION (ASVAUTO) FOR THE TREATMENT OF CENTRAL SLEEP APNEA ASSOCIATED WITH CHRONIC USE OF OPIOIDS

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Introduction: To compare the efficacy and patient comfort of a new mode of adaptive servoventilation (ASVAuto) with auto titrating expiratory positive airway pressure (EPAP) versus bi-level in patients with central sleep apnea (CSA) associated with use of opioid medications.

Methods: Prospective, randomized, crossover polysomnography (PSG) study. Eighteen consecutive patients (age ≥ 18 years) who had been receiving chronic opioid therapy (≥ 6 months), and had sleep disordered breathing with CSA (central apnea index [CAI] ≥ 5) diagnosed during an overnight sleep study or positive airway pressure (PAP) titration were enrolled to undergo two PSG studies; one with ASVAuto titration and one with bi-level titration with back up respiratory rate. Patients completed two questionnaires after each PSG; Morning-After Patient Satisfaction Questionnaire and PAP Comfort Questionnaire.

Results: Patients had a mean age of 52.9 ± 15.3 years. Opioid medications included oxycodone, oxymorphone, fentanyl, methadone, buprenorphine, hydrocodone, hydromorphone, and morphine. PSG prior to randomization showed an average apnea hypopnea index (AHI) of 50.3 ± 22.2 (45.4) and CAI of 13.0 ± 18.7 (5.3). CPAP or bi-level S titration prior to randomization showed an average AHI of 35.3 ± 18.1 (33.4) and CAI of 18.2 ± 11.8 (13.5). Titration with ASVAuto versus bi-level with back up respiratory rate showed that there were significant differences with respect to AHI and CAI. The AHI and CAI were significantly lower on ASVAuto versus bi-level [2.5 ± 3.5 (0.3) versus 16.3 ± 20.9 (6.6) ($p = 0.0005$), and 0.4 ± 0.8 (0) versus 9.4 ± 18.8 (1.5) ($p = 0.0002$), respectively]. Patients felt more awake, alert, and rested on ASVAuto versus bi-level based on scores from Morning-After Satisfaction Questionnaire ($p = 0.0337$). Although not significant, there was a trend towards higher comfort and satisfaction with ASVAuto versus bi-level therapy on the PAP Comfort Questionnaire.

Conclusion: The new adaptive servoventilation with auto-titrating EPAP (ASVAuto) was significantly more effective than bi-level therapy with back up respiratory rate for the treatment of CSA associated with chronic opioid use.

Support (If Any): Study was sponsored by ResMed Science Center, ResMed Corp., San Diego, California, USA.

0408

IS CENTRAL SLEEP APNEA (CSA) A MARKER OF SUBCLINICAL CARDIOVASCULAR DISEASE (CVD)?

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Introduction: We assessed whether the presence of CSA on overnight polysomnography is a marker for reduced left ventricular (LV) function and whether it is associated with LV mass or concentric remodeling defined as LV mass/volume ratio.

Methods: We analyzed 1412 participants from the Multi-Ethnic Study of Atherosclerosis (MESA) who underwent both overnight polysomnography and cardiac MRI. Subjects had been recruited 10 years earlier when free of CVD. Our main exposure is the presence of CSA as defined by central apnea-hypopnea index (AHI) ≥ 5 or presence of Cheyne

Stokes Breathing. Outcome variables were LV mass/height, LV ejection fraction (EF), LV end-diastolic volume (LVEDV), and LV mass/volume ratio. Between-group differences were assessed with the Fischer's Exact Test, 2-sample t test, and the Wilcoxon rank-sum test. Multivariate linear regression models adjusted for age, gender, race, and hypertension were fit for the outcomes.

Results: Of the 1412 participants (mean age 58.5; 46.4% male), 27 (2%) individuals had CSA. Subjects with CSA were more likely to be men (88% vs. 54%, $p = 0.0013$), older (median age 80 vs. 67 years, $p < 0.0001$), and have a lower BMI (BMI 25 vs. 28, $P = 0.026$). These groups did not differ in the prevalence of diabetes or hypertension although those with CSA had a significantly elevated obstructive AHI (31.23 vs. 7.75, $P < 0.0001$). There were no statistically significant differences in LV mass ($p = 0.1004$), LVEDV ($p = 0.156$), and LVEF ($p = 0.267$) between the two groups. However, LV mass/volume ratio was significantly higher in the CSA group even after adjusting for age, gender, race, and blood pressure ($p = 0.0279$).

Conclusion: In a community based sample of adults initially recruited to be free of clinical CVD, participants with CSA have higher LV mass/volume ratio suggestive of concentric remodeling. On the contrary, CSA is not related to LV mass and LVEF.

0409

COMPARISON OF CIRCULATION TIME IN HEART FAILURE (CHEYNE STOKES RESPIRATION-CENTRAL SLEEP APNEA VS. OBSTRUCTIVE SLEEP APNEA)

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Introduction: Periodic breathing with prolonged circulation time (CT) is a hall mark of Cheyne Stokes Respiration-Central Sleep Apnea (CSR-CSA) in heart failure (HF). Increased CT has also been described in obstructive sleep apnea (OSA) in the setting of HF. We sought to compare lung to periphery CT measured from polysomnography (PSG) between CSR-CSA and OSA in patients with HF.

Methods: PSGs of the patients with a history of HF and documented reduced left ventricular ejection fraction ($< 40\%$) from two sleep centers were reviewed in a consecutive manner to identify cases of CSR-CSA (According to 2007 AASM recommended scoring rules) and OSA (defined by obstructive AHI ≥ 10). Averages of 8 random lung to finger CT (LFCT) were obtained per patient during NREM stage sleep. LFCT (mean \pm SD) were compared between the two groups using linear regression.

Results: Among total of 35 cases (CSR-CSA: N = 16, OSA: N = 19; Male: 23, Female: 12) identified, patients with CSR-CSA tended to be older and have lower body mass index (BMI) and EF (Age: 65.1 ± 12.3 vs. 59.5 ± 9.5 , $p = 0.14$; BMI: 33.5 ± 6.1 vs. 38.5 ± 8.2 kg/m², $p = 0.054$; EF: 30.2 ± 10.2 vs. $35.3 \pm 5.4\%$, $p = 0.07$). LFCT in CSR-CSA was significantly longer compared to OSA (41.1 ± 10.8 vs. 28.4 ± 7.2 (sec), $p = 0.0002$). The difference remained significant after adjusting for age and BMI (Adjusted mean [SE]: $40.4 [2.2]$ vs. $28.9 [2.0]$ sec, $p = 0.0008$). Age, but not BMI, was also found to be significantly associated with the LFCT (Age: β coefficient = 0.36, $p = 0.02$; BMI: β coefficient = 0.15, $p = 0.5$).

Conclusion: Prolongation of LFCT was significantly more pronounced in patients with CSR-CSA compared to OSA. LFCT may be a useful metric in differentiating the two subtypes of sleep apnea in HF.

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0410

CENTRAL SLEEP APNEA AND AUTONOMIC OUTCOME AFTER ELECTIVE CAROTID REVASCULARIZATION: DIFFERENT EFFECTS OF CAROTID ENDARTERECTOMY (CEA) AND CAROTID ARTERY STENTING (CAS)

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Introduction: Carotid stenosis interferes with peripheral chemoreceptor function and increases peripheral chemoreflex sensitivity (CRS). Increased CRS enhances ventilatory drive which primarily emerges as periodic breathing during sleep (central sleep apnea, CSA). CSA is highly prevalent and results in autonomic dysfunction in patients with asymptomatic extracranial carotid stenosis. The impact of carotid revascularization on autonomic function and peripheral chemoreflex sensitivity, reflected by CSA, as major prognostic factors of cardiovascular health has never been systematically examined.

Methods: Autonomic function was analyzed by heart rate variability (HRV), baroreflex sensitivity (BRS), respiratory CRS (CSA) and cardiac CRS in 42 patients with $\geq 70\%$ asymptomatic extracranial carotid stenosis prior and four weeks after carotid revascularization (CEA n = 24, CAS n = 18).

Results: Post-interventional HRV determined by total band power was higher in patients with CEA than CAS ($p < 0.009$) indicating superior autonomic function. Post-interventional HRV depended on pre-interventional HRV ($p < 0.002$) and tended to be associated with presence of bilateral stenosis ($p < 0.059$) and age ($p < 0.092$). Post-interventional BRS was neither determined by intervention nor by pre-interventional BRS, presence of bilateral stenosis and age. Post-interventional respiratory and cardiac CRS was lower in the CEA group ($p < 0.014$, $p < 0.0001$) indicating better chemoreceptor function. Post-interventional respiratory CRS was also determined by pre-interventional respiratory CRS ($p < 0.001$), presence of bilateral stenosis ($p < 0.016$), but not by age.

Conclusion: Autonomic function is superior after CEA compared to CAS. Impaired pre-interventional autonomic state and presence of bilateral stenosis additionally decrease post-interventional autonomic function. Improved autonomic function after CEA is primarily based on restoration of chemoreceptor (decreased CSA) but not on baroreceptor function and may improve cardiovascular long-term outcome.

Support (If Any): The study was supported by the Reinhard Loewenstein Foundation.

0411

SLEEP DISORDERED BREATHING TREATMENT WITH TONGUE STABILIZER DEVICE: RANDOMIZED CROSS-OVER CLINICAL TRIAL, PRELIMINARY DATA

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Introduction: Obstructive sleep apnea (OSA) treatment with intra-oral devices can be effective especially in mild/moderate OSA. The tongue retention devices (TRDs) demonstrated significantly respiratory events reduction during sleep and improved sleep quality. The objective of this study was to evaluate the efficacy of TRDs in the treatment of OSA.

Methods: We included patients with OSA treated in outpatient clinic Neuro-Sono Sleep Center, Neurology Department, Escola Paulista de Medicina, São Paulo, Brazil. Patients with mild or moderate OSA on polysomnography were randomized to start treatment with one of two types of interventions: TRD or dental splint (placebo). Patients were treated for four weeks and then the second polysomnography was per-

formed using the interventions that were randomly allocated. This study continues under blinding and interventions are referred to as A or B, to keep the allocation concealment.

Results: We consecutively included 75 patients, of whom 15 did not meet the inclusion criteria and 18 did not attend for evaluations. Forty two patients were randomized. Twenty one began treatment with device A and 21 with device B. There were 7 dropouts in total. Among the patients who used device A, only one patient showed no snoring at the end of treatment, compared to 9 patients in group B ($p = .008$). In the intra-group analysis, for intervention with device A, there was no difference in mean AHI, oxyhemoglobin desaturation, and sleep efficiency at baseline and at the endpoint, and for device B, the mean AHI decreased from 18.4 to 12.1 events/hour ($p = .05$), the oxyhemoglobin desaturation increased from 82 to 84%, but the sleep efficiency decreased from 82 to 77%. The sleep efficiency was lower from device B (77%) compared to device A (88%, $p < .05$).

Conclusion: Intervention with devices B seems to be more effective in solving snoring problems, reducing AHI, and desaturation, but it reduced sleep efficiency.

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0412

EFFECT OF MOBILE TESTING, TREATMENT AND CARE MANAGEMENT FOR OBSTRUCTIVE SLEEP APNEA ON ADHERENCE AND CLINICAL OUTCOMES IN PROFESSIONAL DRIVERS OVER 12 MONTHS

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Introduction: Data indicate that up to 30% of professional drivers in the US may have sleep apnea and that first year adherence rates to OSA treatment may be as low as 50%. A novel approach integrating ambulatory diagnostics and therapeutics with OSA care management was used to determine effects on adherence and clinical outcomes.

Methods: Professional drivers employed by JB Hunt for at least 1 year were recruited to participate in a prospective 12-month study and selected due to a high probability for OSA. Following an IRB approved Informed Consent, subjects completed ESS, FSS, SF-36, FOSQ, the Berlin questionnaire, a sleep history, physical exam, and underwent a portable sleep test in their truck cab or nearby the company terminal in Forrest Park, GA. Two blinded board-certified sleep technologists and a single board-certified sleep physician analyzed data. Subjects were treated for OSA (AHI > 15) with an auto-titrating positive airway pressure (APAP) device (ResMed, Inc., San Diego, CA) equipped with remote monitoring capabilities. Technology-enabled exception management was used with immediate sleep medicine, behavioral and technology back up. After 12 months the SF-36, FOSQ, ESS, and FSS were repeated and two-tailed t-tests performed to establish significance.

Results: Total of 91 professional drivers (98% male) enrolled over a 2-year period; 72 diagnosed with OSA; 55 completed the 12-month protocol (36 [65%] severe [AHI > 30], 17 [31%] moderate [AHI > 15; < 30], 2 [4%] mild [AHI < 15]). At 12 months, compliance was 88% (48/52) with average use rate of 82%. Significant clinical benefits were noted on pre-post ESS, FSS, FOSQ and specific SF-36 domains.

Conclusion: This prospective trial demonstrates that utilizing available PAP monitoring technology and proactive sleep management to identify, intervene and resolve therapy issues can result in excellent adherence as well as significant benefits in clinical outcomes.

Support (If Any): JB Hunt sponsored research project; ResMed support obtained for treatment devices; Natus support for Embletta testing devices.

0413

TITRATION OF UPPER AIRWAY STIMULATION IN THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA

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Introduction: Upper airway stimulation (UAS) is a novel therapy for treatment of moderate to severe obstructive sleep apnea syndrome, by stimulating the hypoglossal nerve to advance the tongue. There are no guidelines for programming stimulation amplitude for optimal treatment. We hypothesize that UAS stimulation amplitude can be initially programmed based on awake testing and then titrated during polysomnography (PSG) for long-term use.

Methods: 126 patients were implanted with UAS and followed for 18 months. We collected patient-specific stimulation amplitude at three levels during awake testing: sensation threshold (ST, subject first felt stimulation), functional threshold (FT, bulk tongue motion) and sub-discomfort threshold (SD, highest comfortable amplitude). UAS was activated with stimulation amplitude set to 0.1 volts (V) above the patient's own FT. Patients could increase amplitude on their own within a set amplitude range during the initial acclimatization period. One month following activation, patients underwent PSG with stimulation amplitude programmed to minimize obstructive apneas and hypopneas similar to CPAP titration.

Results: From one month to 18 months, ST remained unchanged (1.2 ± 0.6 V vs. 1.1 ± 0.6 V, $p = 0.25$), FT remained unchanged (1.8 ± 0.8 V vs. 1.8 ± 0.7 V, $p = 0.93$), and SD increased (2.5 ± 0.9 V vs. 2.7 ± 1.0 V, $p = 0.003$). Among 69 patients who had the same bipolar electrode configuration, stimulation amplitude was 2.4 ± 0.8 V after initial titration at 2 months and 2.2 ± 0.8 V after 18 months ($p = 0.15$).

Conclusion: Stimulation thresholds of upper airway stimulation were stable over time. Therapy activation can utilize functional threshold for initial amplitude programming. Stimulation amplitude titrated using PSG remained stable after 18 months.

Support (If Any): Inspire Medical Systems.

0414

TREATMENT OF OBSTRUCTIVE SLEEP APNEA IMPROVES MENOPAUSE RATING SCALES

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Introduction: Menopause is characterized by physiologic and psychosocial changes in a woman's life. The associated vasomotor symptoms, sexual dysfunction, mood changes and sleep disturbances can have a significant impact on quality of life. The Menopause Rating Scale (MRS) is a standardized, reliable, and validated self-administered scale used to evaluate the severity of symptoms over time. The prevalence of Obstructive Sleep Apnea (OSA) increases markedly at menopause for reasons that include weight gain and unclear hormonal mechanisms. The effect of treatment of OSA on MRS score is unknown. We hypothesized that the treatment of OSA will have a positive impact on the MRS score.

Methods: We prospectively analyzed a cohort of 17 post-menopausal women diagnosed with OSA presenting to the George Washington-Medical Faculty Associates Center for Sleep Disorders. They were treated with continuous positive airway pressure (CPAP). Pre-treatment MRS scores were compared with three-month post-treatment MRS scores using the Wilcoxon signed-rank test.

Results: The mean baseline apnea-hypopnea index (AHI) was 41.3 events per hour [6.5-106.6]. The mean baseline MRS score was 17.1 [7-25]. All 17 patients were treated with CPAP and their MRS was reassessed approximately 3 months later [mean = 89.6 days; 32-183 days]. The repeat MRS had a mean score of 9.2 [3-18]. The difference in the MRS scores was statistically significant ($p = 0.0005$).

Conclusion: CPAP appears to be beneficial in ameliorating menopause-related symptoms. These findings suggest that postmenopausal women should be screened for the presence of OSA. Larger, prospective studies are needed to validate these findings and to identify how CPAP treatment leads to improvements of these symptoms.

0415

USE OF CLINICAL VIDEO TELCONFERENCING TO IMPROVE VETERANS SLEEP APNEA CARE

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Introduction: Obstructive sleep apnea (OSA) is highly prevalent in the Veteran population. Because research shows that adherence patterns with continuous positive airway pressure (CPAP) are established early in treatment, we evaluated a clinical video teleconferencing system that enables early and frequent productive interactions between patient and provider, with the goal of providing patient-centered, collaborative care.

Methods: The evaluative aspect of this project was a pilot randomized, controlled clinical trial of Video Teleconferencing (VTC) compared to Usual Care (UC). The key feature of the Video Teleconferencing intervention was the use of a telemedicine system that allows for audio/visual conferencing with the patient in their home environment from the start of treatment initialization through two-months of follow-up. The provider is able provide more direct feedback to the patient based on the telemedicine interaction (relative to phone calls) and patients benefit from increased support.

Results: There were no baseline differences in age, apnea-hypopnea index (AHI), body mass index (BMI), or Epworth Sleepiness Scale (ESS) between the two groups. Nightly CPAP adherence measured over the two-month period was 3.4 ± 2.4 vs. 3.6 ± 1.8 hours per night ($p = 0.80$) for the VTC and UC groups, respectively. Substituting in-person clinic visits with interactions via Video Teleconferencing (VTC) resulted in no degradation of CPAP adherence between the two groups. The groups did not differ on other outcomes measures, including OSA symptoms, daytime sleepiness, sleep quality and depressive symptoms.

Conclusion: The study was informative in revealing both the advantages and disadvantages associated with using Video Teleconferencing with OSA research participants in their home environments. The advantages were clear: VTC allowed for more frequent interactions between patient and provider with a visual component, and saved the patient time and effort associated with clinical visits. The main disadvantage was technical issues with dropped calls.

Support (If Any): VA_HSRD_PPO_10-101.

0416

LONG-TERM QUALITY OF LIFE OUTCOMES WITH UPPER AIRWAY STIMULATION FOR TREATMENT OF OBSTRUCTIVE SLEEPAPNEA

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Introduction: After 12 and 18 months of therapy, upper airway stimulation has been shown to improve the AHI in moderate to severe obstructive

sleep apnea (OSA) patients who do not adhere to CPAP therapy, however the long-term quality of life impact is not yet known. This study examines the quality of life impact after 12 and 18 months of therapy

Methods: All implanted subjects were screened with overnight polysomnography (PSG), surgical consultation, and drug-induced sleep endoscopy (DISE). Subjects free of complete concentric retropalatal collapse were implanted with a neurostimulator (Upper Airway Stimulation system, Inspire Medical Systems, Minnesota). Quality of life measures collected after 12 and 18 months of therapy included ESS, FOSQ, self reported snoring, and sleep-partner reported snoring. Snoring was measured on a semantic scale with options: no snoring, soft snoring that does not interrupt the bed partner, loud snoring that disturb the bed partner, very intense snoring, or bed partner leaves room.

Results: The average age of the 126 implanted subjects was 54.5 ± 10.2 yrs with BMI of 28.4 ± 2.6 kg/m² and AHI of 32.0 ± 11.8 at baseline. Median ESS reduced from 11.0 at baseline to 6.0 after 12 months ($P < 0.0001$) and remained at 6.0 after 18 months. Median FOSQ increased from 14.6 at baseline to 18.2 after 12 months ($P < 0.0001$) and remained at 18.4 after 18 months. Patients reporting no or soft snoring increased from 22% at baseline to 86% at 12 months and 88.4% at 18 months. Sleep partners reporting no or soft snoring increased from 17% at baseline to 86% after 12 months and 87.4% after 18 months.

Conclusion: Upper airway stimulation improved quality of life measures for daytime function and sleepiness, and reduced snoring through 18 months.

Support (If Any): Inspire Medical Systems.

0417

SAFETY AND EFFECTIVENESS OF ORAL PRESSURE THERAPY WITH A NEW ORAL INTERFACE

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Introduction: Treatment of obstructive sleep apnea (OSA) utilizing controlled vacuum applied to an oral interface (Winx) has been reported. To further facilitate tongue position during sleep with oral pressure therapy (OPT), an alternate mouthpiece (Winx+, ApniCure) was developed. This trial evaluated the safety and effectiveness of this new mouthpiece in comparison to the currently clinically available device.

Methods: Adult subjects with moderate or severe OSA and no prior experience with OPT were studied with a cross over design, comparing the Winx to the Winx+ device assigned in random order. Subjects underwent baseline attended polysomnography followed by attended polysomnography with the treatment device, then 4 nights of home use, followed by a minimum 3 day washout. Treatment polysomnography and subsequent home use was then repeated with the other mouthpiece.

Results: Thirty subjects (15 no prior OSA therapy, 8 CPAP users, 7 former CPAP users) completed baseline polysomnography and polysomnography with each mouthpiece. At baseline, 1 subject had mild OSA, 14 subjects moderate, and 15 severe. Age was 50.5 ± 9.1 years (mean \pm SD), BMI was 32.7 ± 5.8 kg/m² (range 18.1-48.1) and 21 subjects were male. Baseline apnea hypopnea index (AHI) (36.6 ± 20.6 events/hour) was significantly reduced both with Winx+ treatment (18.0 ± 19.6) and with Winx treatment (26.5 ± 24.4). AHI achieved with Winx+ was significantly lower than with Winx ($p < 0.05$, repeated measures ANOVA, Tukey). The combination of treatment AHI ≤ 15 events/hour and AHI reduction with treatment $\geq 50\%$ was observed in 40% of subjects with

Winx and 63% of subjects with Winx+ ($p < 0.05$, binomial). There were no severe or serious adverse events and no subject required medical intervention.

Conclusion: Oral pressure therapy with the Winx+ mouthpiece was safe and effective for the treatment of OSA. The addition of this mouthpiece to clinical practice may allow OPT to be an appropriate therapy option for more patients.

Support (If Any): ApniCure.

0418

TRAINING FACIAL MUSCLES REDUCES SNORING

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Introduction: We hypothesized that training of facial muscles using an oral exerciser (Facial flex (FF), Facial Concepts) would reduce the objective amount of snoring. The device is FDA approved for treatment of muscle laxity. Users of the device have reported a decrease in snoring. The device is placed horizontally between the upper and lower lips and seated at the corners of the mouth. The user presses the corners of the lips together against the device resistance (elastic bands) to make the smallest “O” possible. The position is held for a few seconds and released. The sequence of compression-release is repeated for two minutes or until the muscle fatigue.

Methods: Subjects underwent home sleep testing (HST) using a type 3 device (Sleep Scout, CleveMed) before and after 6 weeks of twice daily muscle training. Selection criteria included a history of snoring and an AHI < 5 /hour on the first HST. Snoring was scored using automated scoring of the nasal pressure signal. Statistical analysis was performed with the analysis of covariance using % of spine sleep as the covariant.

Results: Eighteen subjects were enrolled and 14 completed training and testing. Three subjects withdrew and 1 subject was a screen failure (had severe sleep apnea). Of the 14 completer subjects 4 were men and 10 women. The mean age was 50.1 years, height was 65.7 inches, weight was 155 pounds, and BMI was 27.4 kg/M2. The total sleep time (index time) and the % of time in the supine position did not differ between the pre and post HST. The snore index (snore per hour as mean (SD)) decreased from 241.31 (52.3) to 153.9 (35.9), $P < 0.04$. The AHI was unchanged 3.3 (0.7) to 4.2 (1.1)/hour, $P = NS$.

Conclusion: Training of facial muscles using a facial muscle exerciser placed in the mouth for 6 weeks reduced the snoring index in a group of individuals without significant sleep apnea.

Support (If Any): Facial Concepts.

0419

TREATMENT OF OBSTRUCTIVE SLEEP APNOEA WITH NASAL EXPIRATORY POSITIVE AIRWAY PRESSURE (EPAP) DEVICES: A RETROSPECTIVE ANALYSIS OF 50 CONSECUTIVE PATIENTS TREATED WITH COMBINED CONSERVATIVE THERAPY

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Introduction: Nasal EPAP devices are emerging as a useful alternative to CPAP treatment in patients with obstructive sleep apnoea. The efficacies of nasal EPAP devices, in isolation and in combination with avoidance of supine sleep, were evaluated as an alternative treatment option for patients diagnosed with OSA of varying severities.

Methods: A retrospective analysis was performed on consecutive patients diagnosed with obstructive sleep apnoea who were subsequently

treated with Provent nasal EPAP devices. Full overnight polysomnography (PSG) was performed in a laboratory setting at both baseline (diagnostic PSG), and to assess treatment efficacy (treatment PSG) following use of nasal EPAP devices at home for a minimum of 10 consecutive nights. Only patients who were OSA-treatment-naïve and had body-weight change of ≤ 5 kg between diagnostic and treatment PSGs were included. Primary outcome measures included pre- and post-treatment apnoea-hypopnoea index (AHI; alternative AASM criteria), oxyhaemoglobin desaturation index (ODI), arousal index and sleep-efficiency.

Results: PSG data for 50 patients (25 male) were included. Combined results comparing treatment PSG with diagnostic PSG showed a 72% reduction in AHI (19.3 to 5.5), 58% reduction in supine AHI (32.0 to 13.6), 81% reduction in lateral AHI (12.9 to 2.4), 64% reduction in ODI (13.8 to 5.0) and a 30% reduction in arousal index with nasal EPAP. There was a small (3.3%) increase in sleep-efficiency. Nasal EPAP normalised the AHI (≤ 5) in 74% of patients across all OSA severity groups. The percentage of patients with normalised AHI was greater in the mild OSA group (91%) than the moderate and severe OSA groups (67% for each). Combined conservative therapy (nasal EPAP plus supine sleep avoidance) normalised AHI in 48 of the 50 patients, with an average AHI reduction of 88%.

Conclusion: Nasal EPAP devices, particularly in combination with avoidance of supine sleep, are effective at normalising AHI in patients with OSA.

0420

COMBINED EFFECTS OF OBSTRUCTIVE SLEEP APNEA AND AUTONOMIC DYSFUNCTION IN MORBIDLY OBESE PATIENTS RECEIVED BARIATRIC SURGERY

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Introduction: The aim of our study was to investigate the correlation between obstructive sleep apnea (OSA) severity and autonomic nerve system (ANS) in the Asian population for bariatric surgery (BS).

Methods: In this prospective, multidisciplinary and observational study, we reported the results of routine pre-operative OSA- and ANS-related assessments in patients undergoing bariatric surgery in National Cheng-Kung University Hospital from January 1, 2011 to December 31, 2012. Objective assessments included overnight polysomnography (PSG) and ANS function evaluation with challenge tests (eg. baseline, deep breathing response, head-up tilt test, valsalva maneuver, cold pressor test and mental arithmetic test). Subjective assessments used questionnaires (Epworth Sleepiness Scale, Snore Outcomes Survey and Pittsburgh Sleep Quality Index).

Results: A total of 81 obese subjects (34 men and 47 women) completed the study. The body mass index (BMI) was 43.5 ± 8.7 kg/m². The overall prevalence of OSA was 86.4%. Patients with moderate to severe OSA (apnea-hypopnea index [AHI] ≥ 15) were significantly male predominant, older, and had a larger neck circumference than those with mild OSA ($p < 0.05$). Low-frequency / high frequency ratio was significantly different between mild OSA and moderate to severe OSA ($p = 0.035$). AHI level was associated with tilt-induced drop in systolic-/diastolic-blood pressure ($p = 0.033$ and $p = 0.031$, respectively). Systolic-/ diastolic-blood pressure changes (Δ SBP and Δ DBP, mmHg) during the cold

pressor test (CPT) in patients with moderate to severe OSA were significantly different from those observed in the subjects with mild OSA ($p = 0.024$ and $p = 0.021$, respectively).

Conclusion: High prevalence of OSA and sympathetic hyperactivity were observed in morbidly obese patients.

0421

AIRWAY CHANGES FOLLOWING MAXILLOMANDIBULAR ADVANCEMENT SURGERY FOR OBSTRUCTIVE SLEEP APNEA

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Introduction: Maxillomandibular advancement (MMA) surgery is a well-established surgical treatment for patients with obstructive sleep apnea (OSA). However, little information exists regarding the relationship of soft tissue to hard tissue advancements on the airway.

Methods: This retrospective pilot study examined patients who underwent MMA surgery for treatment of OSA. Each patient underwent a preoperative and postoperative polysomnogram, determination of Apnea-Hypopnea Index (AHI) and lateral cephalometric evaluation of their airways. All surgeries were performed by the same surgeon (KB).

Results: Eight patients were included in this study, 7 males and 1 female. Surgical Cure was defined as a post-operative AHI < 5 , and Surgical Success defined as AHI < 20 and an overall reduction of AHI $\geq 50\%$. The Surgical Cure and Success rates were 50% and 75%, respectively. The average pre- and post-operative BMI for this sample was $31.34 \pm 3.89 \text{ kg/m}^2$ and $30.93 \pm 4.59 \text{ kg/m}^2$, respectively. Cephalometric analysis revealed mean advancement of the mandible was $9.80 \pm 11.67 \text{ mm}$, and mean advancement of the maxilla was $10.84 \pm 5.11 \text{ mm}$. The ratio of change in soft tissue advancement of the posterior airway space (PAS) to mandibular advancement was 0.74:1. Standard T-test analysis was performed on all data samples. The average pre-and post-operative AHI were 49.69 ± 30.13 , and 5.41 ± 5.31 , respectively ($p < 0.01$). Statistical significance was achieved in the change in PAS ($p < 0.01$) and ESS ($p < 0.05$). There was a moderate correlation between change in AHI and (1) maxillary advancement ($R = 0.499$) and (2) PAS ($R = 0.571$).

Conclusion: We conclude that MMA is highly successful for treating OSA, and provides significant positive changes to with significant positive effects on the airway. Ratios to predict soft to hard tissue results are 0.74:1. A strong relationship exists between improvement in AHI and (1) maxillary advancement, and (2) PAS.

0422

EFFECTIVENESS OF CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) AND ORAL APPLIANCE (OA) OVER MILD OBSTRUCTIVE SLEEP APNEA SYNDROME (OSAS): A RANDOMISED, PARALLEL, SIMPLE, BLIND, CONTROLLED STUDY

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Introduction: Studies which evaluated response to treatment with both CPAP and OA in mild OSAS patients present conflicting results. To evaluate the effectiveness of treatments with CPAP and OA in mild OSAS patients, on subjective and objective somnolence, cognitive deficits, sexual function, mood, life quality and metabolic, cardiovascular and hormonal changes.

Methods: 25 volunteers, both genders, Body Mass Index $\leq 35 \text{ kg/m}^2$, 18-65 years old with mild OSAS (Apnea-Hypopnea Index (AHI) between 5 and 15) patients were included and randomized into groups:

CPAP, OA and Control. All underwent the following tests at baseline and after six months of treatment: full polysomnography, Maintenance of Wakefulness Test (MWT), subjective assessment of mood (Anxiety and Depression Beck Inventory), Epworth Sleepiness Scale (ESS), Functional Outcomes of Sleep Questionnaire (FOSQ), World Health Organization Quality of Life Questionnaire (WHOQoL-Bref), Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36), Modified Impact Fatigue Scale (MIFS), sexual function, blood tests, Ambulatory Blood Pressure Monitoring (MAPA), Peripheral Arterial Tone (EndoPAT), and Performance Vigilance Test (PVT). Control group was instructed to follow behavioral measures (sleep hygiene, fitness and nutrition). Study was approved by UNIFESP Research Ethics Committee, CEP N°1300/11, registered in Clinical Trials: NCT01461486.

Results: OA Group ($n = 10$), CPAP Group ($n = 6$), Control Group ($n = 6$). The results were adjusted to age and BMI. CPAP compared with control had positive results in the following variables: Arousal Index decrease ($p = 0.03$), AHI decrease ($p = 0.006$), Minimum Saturation increase ($p = 0.03$). OA was more effective than Control with regard to AHI decrease ($p = 0.003$). However, CPAP reduced AHI to a significantly higher level compared with OA ($p = 0.04$). There were no significant differences between CPAP and OA for other variables analyzed.

Conclusion: CPAP performed better than OA for the treatment of mild OSAS.

0423

QUALITY OF LIFE CHANGES IN BED PARTNERS OF OBSTRUCTIVE SLEEP APNEA PATIENTS AFTER TREATMENT WITH ORAL APPLIANCES

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Introduction: It is reported that CPAP could affect improvements in the QOL of bed partners. In OA (oral appliance) studies, some reports suggest effectiveness in patient's QOL variables but it is unclear about the bed partner's QOL. The aim of this study was to examine the effects on the QOL of both parties after the patients were treated with an OA.

Methods: This study is a simple questionnaire survey administered by asking the patient to complete it at his/her home before and after OA therapy. The questionnaire consists of the Short Form 36 (SF-36), the Epworth sleepiness scale (ESS) and general questions requesting information such as snoring habits and sharing the bedroom details. Wilcoxon Signed Ranks test and Spearman test were used for statistical analysis. A $P < 0.05$ was considered as significant.

Results: A total of twenty patients (65% male, age 52.9 ± 9.9 years, BMI $26.3 \pm 4.8 \text{ kg/m}^2$, baseline ESS 7.1 ± 3.1) and ten partners (10% male, age 49.9 ± 9.7 years, baseline ESS 4.4 ± 3.0) completed the data collection. In addition to significant improvements on patients ESS and bed partner's physical function, a higher adherence (frequency of wearing an OA nights/week) correlated with an improvement in patients QOL variables (role physical $r = 0.512$, vitality $r = 0.465$, role emotional $r = 0.488$, and mental health $r = 0.485$, $p < 0.05$). The greater the snoring reduction correlated with an improvement in bed partners ESS score ($r = -0.744$, $p < 0.05$) and QOL variables (role physical $r = 0.632$, mental health $r = 0.848$, physical health $r = 0.848$ and total SF36 score $r = 0.780$, $p < 0.05$).

Conclusion: The results indicate that bed partners who reported a greater reduction in patient's snoring experienced an improvement in their own sleepiness and QOL. An assessment of changes in sleepiness and QOL variables in bed partners based on a larger sample size is warranted to evaluate the potential changes that occur.

0424

COMPARISON OF CLINICAL AND POLYSOMNOGRAPHIC OUTCOMES BETWEEN MANDIBULAR ADVANCEMENT DEVICE (MAD) WITH NEUTRAL POSITIONING, POSITIVE AIRWAY PRESSURE THERAPY (PAP) AND A COMBINATION OF MANDIBULAR ADVANCEMENT DEVICE (MAD) AND POSITIVE AIRWAY PRESSURE THERAPY (MAD+PAP) IN 106 CASES OF OBSTRUCTIVE SLEEP APNEA WHO WERE CUSTOMIZED WITH A MANDIBULAR ADVANCEMENT DEVICE (MAD)

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Introduction: PAP therapy is a gold standard for treatment of OSA and outcome studies show reduced cardiovascular/cerebrovascular risk. However, some patients have complications of PAP therapy such as peripheral and peri-orbital edema, exposure kerato-conjunctivitis, bloating, neck pain and insomnia while others abandon PAP after years of successful use. Mandibular Advancement Devices (MAD) have successfully treated mild to moderate OSA and reduced severe OSA when PAP failed. The long-term cardiovascular or cerebrovascular benefits, however, remain unconfirmed and combination therapy (MAD+PAP) has not been tested.

Methods: 106 subjects with OSA confirmed by polysomnography underwent customization of MAD. They were subjected to a brief trial with MAD and nasal PAP immediately after customization of MAD using PAP pressures of 4-8 CWP. Weeks later they had a split night polysomnography (3 hours of MAD followed by addition of nasal pillow mask with PAP). They then had a clinic visit.

Results: Cases controlled on MAD were placed on MAD while those that did equally well on MAD or PAP chose one or the other and even preferred to use PAP at home and MAD when they travelled. The patients that were not controlled on MAD alone were placed on combination therapy with MAD+PAP. Clinic follow-up was performed to assess symptom control and reduction in complications of OSA (HTN, GERD).

Conclusion: MAD controlled mild/moderate OSA. In previous PAP users MAD reduced PAP pressure or eliminated PAP use. MAD improved compliance (travelling, allergic rhinitis, 'partial night therapy'). MAD reduced complications like peripheral edema. The MAD+PAP or MAD/PAP adequately controlled OSA (polysomnography proven), reduced complications and improved compliance.

0425

USABILITY OF HIGH FLOW THERAPY IN COPD PATIENTS

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Introduction: COPD is characterized by progressive worsening of ventilation and impaired pulmonary gas exchange, parameters that are further worsened by hypoventilation associated with sleep. High flow therapy (HFT) a novel treatment that delivers humidified air via a nasal cannula has been shown to decrease ventilatory demand in COPD patients during sleep; however there is currently no data on HFT usability. The aim of the current study was to objectively and subjectively determine the usability of HFT during sleep at home in patients with mild to moderate COPD.

Methods: We studied ten individuals (men: women; n = [2: 8]; age = [63 ± 7: 65 ± 8 yrs (Mean, SD)]) with diagnosis of mild to moderate COPD. HFT devices were set to deliver air at a flow rate of 25 L/min, 85% humidity and a temperature of 33 degree Celsius. Participants were asked to use HFT during sleep at home for one week. Raw data airflow traces recorded from the device was used to categorize objective adherence

into total time on device (TToD) and effective usage (EFF) (Total time on device – nasal cannula dislodgement). Subjective usability was assessed using self-reported sleep diary (reported use) and a 10 point Likert acceptability scale (0 = Very unacceptable to 10 = Very acceptable). We compared the group means of subjective (reported use) to objective (TToD, EFF) usage.

Results: The individual participant values for both the objective (TToD, EFF) and reported usage are presented in the table below. For the group the reported use (7.3 ± 2.6 [2.0, 10.7]; mean ± SEM [range]) was consistently higher than both TToD (6.0 ± 2.6 [1.1, 8.8]) and EFF (4.0 ± 1.8 [0.0, 5.9]) (all $p < 0.001$). Fifty percent of individuals had effective usage time greater than 4 hrs per night. Nine out of the 10 participants found the HFT very acceptable.

Conclusion: The HFT was very well accepted by most participants, with a strong similarity between reported usage and total time on HFT. The effective usage time was consistently lower than reported usage and time on device for the spectrum of participants. We demonstrate the need for objective measurements of effective treatment usage in home base therapies so as to reduce confounding and increase validity of home studies.

0426

MANDIBULAR ADVANCEMENT DEVICE TITRATION USING A REMOTELY CONTROLLED MANDIBULAR POSITIONER

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Introduction: In obstructive sleep apnea (OSA) treated with a mandibular advancement device Remmers et al recently showed that therapeutic outcome was predicted by a titration study in the laboratory using a remotely controlled mandibular positioner (RCMP, SomnoMed MATRx™, Zephyr Sleep Technologies Inc., Canada). Furthermore this study showed that optimal titration could be established in a single night. We report on use of the RCMP in a clinical sleep practice.

Methods: 30 patients (22M/8F, BMI 26 ± 3 kg/m²) with pre-treatment AHI (AHI_{Dx}) < 30/hr (n = 18), or AHI_{Dx} ≥ 30/hr who refused CPAP (n = 12) were studied with RCMP during a full night polysomnography (PSG). Baseline and maximum jaw advancement (ADVmax) was determined prior to study by a dentist. During PSG, RCMP was progressively advanced past baseline to ADVmax until all obstructive events were eliminated (ADVopt), or until the patient expressed discomfort. AHI_{RCMP} was calculated as the sum of apneas and hypopneas (30% reduction in flow with 3% O₂ desaturation or arousal) divided by the sleep time limited to the section of the RCMP study with optimal/maximal advancement. Successful titration was defined as AHI_{RCMP} < 15. If pre-treatment AHI_{Dx} was < 20, a 50% reduction was also required.

Results: Titration was successful in 20 subjects. (AHI_{Dx} = 34 ± 9 /hr vs AHI_{RCMP} = 9 ± 7 /hr). ADVopt was within 2 mm of ADVmax in 15/20 patients. In the remaining 5 patients the ADVopt was 2-5 mm lower than ADVmax. Titration resulted in no benefit in 10 subjects (AHI_{Dx} = 27 ± 26 /hr vs AHI_{RCMP} = 24 ± 11 /hr).

Conclusions: The RCMP system was used to advance the dental device over a range of jaw advancements and was tolerated by all subjects. In 20/30 subjects successful titration was obtained during the one night titration, with 25% of these subjects requiring less than maximal advancement. Lack of benefit was predicted in 10/30 subjects. The long-term utility of suboptimal advancement, prediction of futility and sustained efficacy need to be addressed separately.

0427

DETERMINANTS OF OBJECTIVELY MEASURED ADHERENCE TO ORAL APPLIANCE THERAPY IN PATIENTS WITH SLEEP-DISORDERED BREATHING

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Introduction: Oral appliance therapy, with oral devices that protrude the mandible during sleep (OA_m), is a non-invasive treatment option for patients with sleep-disordered breathing (SDB). Recently, an objective measurement of adherence during OA_m therapy was validated. The goal of the present study was to determine which parameters were correlated with objective OA_m adherence data.

Methods: In 68 SDB patients (male: 63%; age: 49 ± 9 y; apnea/hypopnea index (AHI): 16 ± 11/h) adherence was objectively measured during OA_m therapy, using a micro thermosensor (TheraMon®, Handelsagentur Gschlady, Austria) sealed in the OA_m (RespiDent Butterfly, Dental Connections, Antwerp). Patients underwent baseline polysomnography and polysomnography with OA_m after 3 months of therapy. Possible correlations between objective adherence and patients' anthropometric characteristics [gender, age, length, weight, BMI], polysomnographic parameters [AHI, total sleep time, oxygen desaturation index, minimum and mean saturation and OA_m efficacy] and two subjective questionnaires [a 10-point visual analog scale (VAS) for snoring and the Epworth Sleepiness Scale (ESS)] were assessed.

Results: The median objective mean wearing time (oMWT) was 6.84 (Q1-Q3: 4.86, 7.37) h/night at 3-month follow-up. None of the anthropometric and polysomnographic parameters was correlated with the adherence in terms of oMWT. No correlation was found between the oMWT and ESS or OA_m efficacy in terms of AHI reduction. However, a significant inversed correlation was found between the oMWT and post-treatment VAS values for snoring ($p < 0.05$ and $\rho = -0.29$). The oMWT correlated significantly with the decrease in VAS for snoring as reported by the partner with OA_m as compared to baseline VAS for snoring ($p < 0.05$ and $\rho = 0.35$).

Conclusion: In this study, a more pronounced decrease in complaints of socially disturbing snoring during OA_m therapy was significantly correlated with better adherence during OA_m therapy.

0428

CHANGES IN 3D NASAL VOLUME AFTER BIOMIMETIC ORAL APPLIANCE THERAPY IN ADULTS

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Introduction: Although continuous positive airway pressure (CPAP) is the first line of treatment for obstructive sleep apnea, patient compliance is often the limiting factor in terms of treatment success. Poor compliance may be a consequence of nasal obstruction, which requires higher CPAP pressures to overcome nasal resistance. Thus, if the nasal airway volume could be increased, patient compliance with CPAP might be improved. Therefore, in this preliminary study we investigated 3D changes in nasal volume, to test the null hypothesis that nasal cavity volume cannot be changed in non-growing adults.

Methods: After obtaining informed consent, we undertook 3D cone-beam computerized axial scans of 11 consecutive, adult patients (mean

age 37.9 yrs) prior to and after biomimetic, oral appliance therapy. These cases had all been diagnosed with midfacial underdevelopment and were treated using a DNA appliance®. The mean treatment time was 18.4 months ± 2.5. To acquire the nasal cavity volume, volumetric reconstruction of the nasal cavity was undertaken between the anterior and posterior nasal spines, extending superiorly from the palatine process of the maxilla and the palatine bone to the cribriform plate of the ethmoid bone. Laterally, the maxillary sinuses were trimmed out at their junction with the nasal cavity. Next, the nasal cavity volume was calculated in all cases. The findings were subjected to statistical analysis, using paired t-tests.

Results: The mean nasal cavity volume was 41.9 cm³ ± 12.1 prior to treatment. After oral appliance therapy, the mean nasal cavity volume increased to 44.0 cm³ ± 12.1 ($p = 0.022$).

Conclusion: These data support the notion that nasal cavity volume can be changed in non-growing adults. Therefore, use of a biomimetic oral appliance in conjunction with CPAP therapy might potentially improve CPAP compliance in adults diagnosed with obstructive sleep apnea by increasing the nasal cavity volume and decreasing nasal airflow resistance.

0429

THE DETERMINING RISK OF VASCULAR EVENTS BY APNEA MONITORING (DREAM) STUDY: DESIGN, RATIONALE AND METHODS

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Introduction: Both obstructive sleep apnea and cardiovascular disease are highly prevalent in the U.S. veteran population. The Determining Risk of Vascular Events by Apnea Monitoring (DREAM) Study was developed to study disordered sleep, particularly obstructive sleep apnea (OSA), as a risk factor for cardiovascular disease in a large U.S. veteran cohort.

Methods: The DREAM study is a multi-site observational cohort study consisting of 1,840 U.S. veterans that underwent in-laboratory polysomnography for the evaluation of OSA between 01/01/2000 and 12/31/2004. Abstracted was information from polysomnography including breathing, sleep and limb movement variables and baseline demographic, health and medication information. Participants were followed for 5.5 ± 1.3 (mean ± SD) years for the development of primary outcomes: (1) coronary heart disease: myocardial infarction, angina, coronary revascularization, (2) cerebrovascular disease: stroke and transient ischemic attack, (3) neoplasm and (4) mortality and secondary outcomes: (1) congestive heart failure, (2) cardiac arrhythmia, (3) peripheral vascular disease and (4) diabetes. The main goal of the DREAM Study is to develop and validate a clinical-prognostic model of cardiovascular disease using sleep-related measures including (but not limited to) apnea-hypopnea index, degree of oxygen desaturation, measures reflecting sleep fragmentation and limb movement frequency.

Results: Results are presented for 1,522 participants for which abstraction has been completed. The cohort is 94.7% male, 77.9% Caucasian with mean age of 58.1 ± 11.7 years. 72.1% of the cohort was hypertensive; 36.1% diabetic; 37.8% past/present smoking; 28.1% coronary artery disease; and 11.3% congestive heart failure. For polysomnographic data, mean apnea-hypopnea index was 25.5 ± 32.2; arousal index 47.6 ± 68.0; and periodic limb movement index 13.0 ± 55.0.

Conclusion: The DREAM cohort is a large U.S. veteran sleep cohort with information regarding polysomnography and cardiovascular disease incidence. This population is at high risk for both sleep disordered

breathing and cardiovascular disease and provides unique opportunities to study the intersection between these two entities.

Support (If Any): VA Merit Review Award; Clinical Science R & D (Yaggi).

0430

ECONOMIC BENEFITS OF CARE MANAGEMENT FOR OSA IN A PROSPECTIVE COHORT OF PROFESSIONAL TRUCK DRIVERS

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Introduction: The economic effects of an OSA treatment program and exception management were tested in association with a 12-month prospective trial in professional truck drivers.

Methods: Professional drivers employed > 1 year with a healthcare claims history at J.B. Hunt were recruited to participate in a prospective 12-month study. Following IRB approved Informed Consent, subjects were tested and those diagnosed with OSA (AHI > 15) were treated with an auto-titrating positive airway pressure (APAP) device and remotely monitored with technology-enabled exception management for 12 months. Claims data and safety metrics were compared pre and post treatment within the study group and between case controls as follows: Group 1: Not participant in sleep study; Group 2: Apnea diagnosis in claims and not included in G1; Group 3: Apnea diagnosis and treatment in claims, not included in G1. Two-tailed t-tests were used to demonstrate significance in pre-post measures.

Results: Controlling for claims cost quartiles, biometrics and comorbid conditions Group 1 (n = 4383); Group 2 (n = 230) and Group 3 (n = 93) were compared with the Study Group (n = 59). Within subjects comparisons demonstrated that per month per member (PMPM) costs in G4 study participants were reduced by 56% versus a 1% reduction in G1. PMPM costs in G4 dropped 48% for versus a 41% reduction for G2 controls. PMPM costs in G4 were reduced 50% versus a 24% reduction for G3 controls. Between subjects comparisons show a 76% reduction in cost for G4 vs G3 and a 73% reduction in cost for G4 vs G2. A mean savings of 60% was demonstrated for G4 vs G1 controls. Pre and post safety data showed minimal statistical significance, but trends were noted.

Conclusion: A proactive technology-enabled sleep apnea management program has measurable economic benefit when compared to standard OSA care pathways using claims-based analysis to determine cost.

Support (If Any): J.B. Hunt support for trial; ResMed support for PAP devices; Natus support for Embletta sleep testing equipment.

0431

SLEEP APNEA PREDICTS KIDNEY FAILURE

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Introduction: Sleep apnea (SA) may be a modifiable risk factor for chronic kidney disease (CKD). CKD affects about 11% of Americans and is associated with cardiovascular death and end-stage kidney disease (ESKD). SA and CKD share common risks and comorbidities.

Methods: We conducted a retrospective cohort study of the 25,229 respondents to the California Men's Health Survey, all of whom were members of Kaiser Permanente Southern California in 2002-03. In 2006-07, members were given the Berlin Questionnaire. These data were linked to electronic health records from 2002-2012. SA was identified by two or more ICD-9 codes or dispensed positive airway pressure (PAP) machines and masks. Kidney function was determined using serum creatinine and standard estimating equations. Outcomes were ESKD and death. Covariates included age, sex, race/ethnicity, Berlin

score, body mass index (BMI), and entry kidney function. Diagnosis codes were used to identify the comorbid conditions of heart failure, hypertension, and diabetes. Multinomial logistic regression was used to determine the relative risk ratio (RRR) of ESKD and death (each outcome vs. neither event).

Results: There were 19,077 subjects with data that were sufficient for analyses (mean age 63 years, mean BMI 28). There were 2,130 cases of SA (11.2% of subjects); 75% had a PAP machine or mask. Death occurred in 483 (2.5%) and ESKD in 63 (0.3%) subjects. The Berlin score was not predictive of outcomes. SA predicted ESKD: RRR 3.59 (95% CI 1.92-6.72) before and 2.96 (1.41-6.21) after adjustment for comorbid conditions. SA did not clearly predict death: RRR 1.29 (0.99-1.69, p = 0.055) unadjusted and 1.14 (0.85-1.53) adjusted. SA did not predict ESKD differently by race/ethnicity or in those dispensed PAP equipment.

Conclusion: Clinically diagnosed sleep apnea was predictive of ESKD more so than death. SA may be a novel risk for kidney disease progression, even if provided PAP therapy.

Support (If Any): NIDDK, Kaiser Permanente.

0432

REGIONAL BRAIN AXIAL AND RADIAL KURTOSIS CHANGES IN RECENTLY-DIAGNOSED PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) shows significant axonal and myelin injury, determined with diffusion tensor imaging (DTI), which is based on Gaussian diffusion. Many brain areas, however, follow non Gaussian diffusion patterns, measurable with recently-developed diffusion kurtosis imaging (DKI) that is more sensitive to tissue changes than DTI. We examined regional brain axial kurtosis (indicating axonal changes) and radial kurtosis values (myelin alterations) in newly-diagnosed, treatment-naïve OSA over control subjects.

Methods: We collected DKI data from 7 recently-diagnosed OSA (age, 43.9 ± 9.7 years; BMI, 33.4 ± 9.1 kg/m²; 5 male; AHI, 35.4 ± 25.7 events/hour) and 14 control subjects (age, 39.6 ± 7.8 years; BMI, 25.1 ± 4.0 kg/m²; 9 male) using a 3.0 Tesla MRI scanner, and assessed regional brain axial and radial kurtosis values between groups using ANCOVA (covariate, age; SPM8, p < 0.005).

Results: Age and gender did not differ between groups; BMI was higher in OSA (p = 0.008). Increased axial kurtosis values in OSA (predominantly axonal changes), appeared in the internal capsule, caudate nucleus, amygdala, anterior hippocampus, hypothalamus, mid corona radiata, parietal, anterior insular, dorsal temporal and occipital cortices, cerebellar peduncles and cortices, and medial medulla. Higher radial kurtosis values (myelin alterations), emerged in the mid corona radiata, posterior internal capsule, putamen, external capsule, internal capsule, and mid-line pons, extending to the medulla. A few areas, including the ventral medulla, mid and posterior insulae, and occipital and frontal cortices, showed increased values in both, suggestive of tissue integrity loss. DKI procedures showed more-widespread injury than previous DTI findings in the insulae, cerebellar peduncles, and medullary areas.

Conclusion: White matter axonal and myelin injury in OSA, assessed by DKI, is even greater than found earlier with DTI procedures. Of concern, the increased injury appeared in medullary and insular areas essential for integrating autonomic action, and motor coordination sites, important for controlling upper airway and diaphragm muscle interactions.

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0433

DETERMINANTS OF DEPRESSED MOOD IN A SAMPLE WITH CO-MORBID OBSTRUCTIVE SLEEP APNEA AND CARDIOVASCULAR DISEASE RISK

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Introduction: Depressive symptoms are common in individuals with obstructive sleep apnea (OSA) and in those with cardiovascular disease (CVD). We examined determinants of depressed mood in individuals with both moderate-severe OSA and CVD risk factors, hypothesizing that higher OSA severity, established CVD, female gender, and sleepiness would be associated with depressed mood.

Methods: Data were collected from 160 participants at a baseline examination conducted as part of the Best Apnea Intervention in Research study. Participants were largely recruited from cardiology practices and had either established CVD or ≥ 3 CVD risk factors, and an Apnea-Hypopnea Index [AHI] ≥ 15 on a screening sleep study. Depressed mood was defined as Patient Health Questionnaire-8 score ≥ 10 ; sleepiness was measured with the Epworth Sleepiness Scale. Data were analyzed using multiple logistic regression.

Results: The sample (age 64.1 yrs) was 66.9% male and had a mean AHI of 30.4. Depressed mood was reported by 15.0% and was more common in women than men (30.2% vs. 7.5%; $p < .001$). Univariate analyses showed that depressed mood was associated with a higher BMI, sleepiness, younger age and overnight hypoxemia, but not with established CVD or AHI. In adjusted analysis, the factors with the strongest associations with depressed mood were female gender (odds ratio [OR] = 5.75; 95% CI [2.13, 15.52]), sleepiness (OR = 1.17 per ESS increment; 95% CI [1.06, 1.30]) and younger age (OR = 0.94 per year; 95% CI [0.88, 1.00]).

Conclusion: Sleepiness but not AHI/hypoxemia levels nor established CVD, was associated with depressed mood in this patient population with OSA and CVD risk factors. Evaluation and treatment of sleepiness in patients with CVD risk factors may improve depressive symptoms, especially in women in whom such symptoms are common.

Support (If Any): NIH / NHLBI (U34105277).

0434

DETERMINATION OF ENDOGENOUS LEVELS OF THE GASOTRANSMITTER HYDROGEN SULFIDE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is an independent risk factor for endothelial dysfunction (ED) that can lead to cardiovascular disease (CVD). Recurrent hypoxemia and re-oxygenation during the apneic cycles cause oxidative stress and inflammation leading to ED.

Nitric oxide (NO) has been shown to play a role in ED in patients with OSA. Recently hydrogen sulfide (H₂S) is speculated to be involved in NO pathway. H₂S levels have been shown to increase in hypoxic conditions which are observed in OSA. However, biochemical and molecular interaction of H₂S in the regulation of NO levels are yet to be fully understood. To date, there are no reports investigating the role of H₂S in OSA pathophysiology, largely due to the lack of reliable methods to measure H₂S levels in clinical samples. This pilot study was designed to measure H₂S levels in OSA patients with a long-term goal of gaining insights on the pathophysiological mechanisms leading to CVD.

Methods: Thirteen patients who presented to an academic sleep center for evaluation for possible OSA were recruited. History, physical examination and overnight polysomnography were obtained. Four ml of venous blood was obtained before sleep as baseline and at the time of diagnosis of OSA (apnea-hypopnea index more than 10 per hour) before CPAP treatment. H₂S levels were assayed using a modified methylene blue method coupled with high performance liquid chromatography.

Results: We were able to detect changes in H₂S levels in 6 patients who qualified for the diagnosis of OSA. Our preliminary analysis indicated a trend towards increase in H₂S levels from baseline to the time of diagnosis in 4 out of 6 patients with OSA.

Conclusion: OSA patients have increase in H₂S levels, which may be associated with cardiovascular disease. Further analysis will be performed to understand the relationship between NO and H₂S levels.

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0435

THE RELATIONSHIP BETWEEN OBSTRUCTIVE SLEEP APNEA AND HOSPITAL READMISSIONS

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Introduction: Improving the quality and effectiveness of health care is a common challenge for health care organizations. Hospital readmissions within 30 days of discharge signal that an adverse event has occurred in a patient's recovery and create a significant burden on health care systems. With the high prevalence of obstructive sleep apnea (OSA) in the general population, the impact as a comorbid medical condition could be substantial. Efforts to optimize comorbid medical conditions are a critical component to improving a patient's overall health. We sought to determine the relationship between OSA and readmissions in a major hospital system.

Methods: A retrospective database review was conducted for all patients discharged from the San Antonio Military Medical Center during a 24 month period. Inpatient records were then matched to the outpatient database for a prior diagnosis of OSA. Readmission rates were determined for patients with and without a diagnosis of OSA to determine association with readmission.

Results: During the 24-month period, 38,549 patients were discharged. 25.0% of all patients had a diagnosis of OSA in their outpatient record. A total of 2,949 readmissions were identified. Of the patients readmitted, 58.6% of patients had OSA. Patients readmitted to the hospital within 30 days, had a higher prevalence of OSA ($p < .001$). Other demographics were also cross-matched.

Conclusion: OSA was a common comorbid condition for admitted patients. OSA appears to be correlated to hospital readmission. Given the inherent morbidity associated with OSA and proven benefit of treatment, optimization in management of sleep apnea should remain a focus. The impact of OSA during the 30 day period following hospital discharge needs further evaluation including the impact of severity and non-compliance.

0436

PREVALENCE OF HYPERTENSION IN MALE AND FEMALE PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) significantly increases the risk for hypertension. There are controversial data concerning the effect of gender on susceptibility to hypertension in OSA. We retrospectively analyzed the prevalence of hypertension in male and female patients with OSA in our institute.

Methods: The study included 3007 patients (2504 males and 44.40 ± 11.53 years old, 503 females and 53.32 ± 11.91 years old) who met the diagnostic criteria of apnea-hypopnea index (AHI) ≥ 5/h through full night polysomnography (PSG) and were diagnosed as OSA. Epworth Sleepiness Scale (ESS) was also collected. The diagnosis of hypertension was based on the diagnosis by the primary physician or use of anti-hypertensive medications.

Results: The AHI varied from 5 to 130.1 with a median of 40.7 (interquartile range: 17.7-65.9) in men, while it varied from 5 to 109.90 with a median of 19.20 (interquartile range: 19.20-43.90) in women. Hypertension was found in 23.0% and 34.2% of men and women, respectively. Regression analysis correcting for age, BMI, AHI, drinking and smoking showed that the odd ratio (OR) for hypertension significantly increased across the severity of OSA (1.0 for AHI 5-15, 1.48 (95% CI: 1.04-2.10) for AHI 15-30, 2.31 (95% CI: 1.50-3.56) for AHI > 30) in men, but not in women. While, across gender, women were at higher risk for hypertension than men (OR 1.44, 95%CI: 1.12-1.85). But, this gender difference was only seen in patients of age > 50 years old (OR 1.60, 95%CI: 1.16-2.22), not in patients of age ≤ 50 years old (OR 1.07, 95%CI: 0.69-1.66).

Conclusion: Our data were characterized by more severe OSA in men than in women, but the average age was nearly 10 years older in women than in men. In this particular patient pool, for patients with OSA, women with age > 50 years old may have a higher risk for hypertension than men.

0437

THE IMPACT OF HYPOXEMIA ON NEPHROPATHY IN EXTREMELY OBESE PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Introduction: Diabetes mellitus (DM) is associated with obstructive sleep apnea (OSA) and nephropathy. The associated hypoxemia may exacerbate renal deterioration in DM nephropathy. We investigate the role of hypoxemia in the development of DM nephropathy in very severe obese patients.

Methods: This cross-sectional study involved 90 obese DM patients attending a specialist weight management service. All patients underwent overnight sleep study. Respiratory parameters measured included apnea-hypopnea index (AHI), mean and minimum oxygen (O₂) saturations and time spent under 90% O₂ saturation (%TST < 90%). Chronic kidney disease (CKD+) is defined as estimated glomerular filtration rate (eGFR) of ≤ 60 ml/min/1.73 m².

Results: Twenty (22%) patients had CKD+, they were 7 years older (mean age 57 ± 11 years, p = 0.003) with greater adiposity (mean body mass index [BMI] 50.6 ± 8.7 kg/m², p = 0.012). No significant differences were found for median AHI and minimum O₂ saturation. %TST < 90% was 4 times greater in CKD+ group (p = 0.046). Multivariate regression analysis showed that AHI (β = -0.017, 95%CI: -0.316 to -0.024) and %TST < 90% (β = -0.215, 95% CI: -0.406 to -0.023) were negatively correlated with eGFR after adjustment for age, gender, BMI, co-morbidities, insulin treatment and drugs affecting renin angiotensin system. No associations were found between mean and minimum O₂ saturations, and eGFR.

Conclusion: Intermittent episodic nocturnal hypoxemic episodes as well as duration of exposure for nocturnal hypoxemia were inversely associated with renal function after adjusting for potential confounders. Greater vigilance should be placed on screening and treatment of OSA on DM patients.

0438

IMPAIRMENTS OF FRONTAL LOBE-RELATED COGNITIVE FUNCTIONS IN SLEEP RELATED BREATHING DISORDER IN THE ELDERLY

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Introduction: The prevalence of sleep related breathing disorders (SDB) increased with aging, and decline of cognitive function is another serious problem in the elderly. However, there were few studies for association between SDB and neurocognitive function of old population in representative samples.

Methods: We recruited 476 elderly subjects (≥ 60 years) from community and a sleep clinic. SDB was diagnosed using laboratory-based polysomnography, and clinical assessments were also conducted. The neurocognitive function test was performed using the Korean version of the Consortium to Establish a Registry for Alzheimer's Disease Neuropsychological Assessment Battery (CERAD-K).

Results: Subjects were divided into 3 groups by severity of SDB; AHI < 15 (control, n = 227), 15 ≤ and 30 < (mild to moderate, n = 128), and 30 ≥ (severe, n = 121). Significant differences were observed among three groups in the Digit Span Forward (p = 0.004) and Backward (p < 0.001). There were modest correlation between AHI and hypoxic variables, and Digit Span (DS), Frontal Assessment Battery (FAB) and Stroop Test (ST) after adjusting for age, educational level, sex and depression. Stepwise multiple regression analysis showed that AHI and hypoxic variables contribute to impairments of DS, FAB and ST.

Conclusion: SDB were modestly associated with decreased neurocognitive function in elderly population mainly through hypoxia. Affected cognitive domains were working memory, attention and executive function which are known to be related with frontal lobe vulnerable to hypoxic insults.

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0439

OBSTRUCTIVE SLEEP APNEA AND OBESITY

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Introduction: We investigated the difference between overweight (> 25 kg/m²) and normal weight patients with OSA in a large cohort (n = 6962) of successively investigated patients.

Methods: Systematic clinical evaluation using a standardized evaluation performed by one individual including oral- facial evaluation, measurements (neck, weight, waist, hip) BP (WHO protocol) blood tests (including blood-glucose and lipids panel), scales (ESS and PSQI) and in-lab polysomnography with AASM scoring criteria.

Results: Normal weight (group A) n = 2474, women: 1086; versus overweight (group B), n = 4488, women: 1589. Group B are significantly older in women (0.006). It is larger neck, waist and hip circumferences (p = 0.001) in men and presence of high BP (p = 0.002) and Diabetes Mellitus (p = 0.001) in women (women: 89%, men 11% versus 5.6 and 5% for A). but no difference in ESS and PSQI results. AHI (mean: women: 39.4, men: 44.6) and SaO₂ (mean: women: 93, men: 93.3%) were much higher than A (women: 13.7 and men: 17.75; 96% and 95.5% respectively) Prevalence of DM is close from general population in OSA < 25 kg/m². In A group AHI (linear regression) is predicted by measurements of neck (coefficients.160) and waist (.276) circumferences, presence of DM (.113) and HBP (.106) with adjusted R² = .218 In group B AHI is predicted by gender (.047), neck (.245) waist (.276) circumferences, HBP (.079) with adjusted R²: (.254).

Conclusion: In this large cohort, there are major differences between normal and overweight OSA patients: ESS is significantly elevated only in B patients while PSQI are abnormal in both group, In overweight patients factors associated with fat distribution are related to AHI and DM is noted with significantly higher frequency. Obesity is directly related to OSA, and its complication suggesting strongly that obesity is the primary factor including for the metabolic changes. The normal weight group is younger with more nocturnal sleep complaints and higher AHI is associated with higher neck and waist circumferences indicating the important role of increase weight in greater PSG abnormalities.

0440

THE ASSOCIATION OF METABOLIC SYNDROME AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) affects at least 1-5% of middle aged individuals in various ethnic populations. The National Cholesterol Education program's Adult treatment panel III recognizes metabolic syndrome as multiple risk factor for cardiovascular disease. The prevalence of metabolic syndrome is increasing with the epidemic of obesity. The presence of obesity to both obstructive sleep apnea and metabolic syndrome prompted several studies that aimed to establish relationship between OSA and metabolic syndrome. It is therefore the aim of this study to determine the association of metabolic syndrome and obstructive sleep apnea among patients at the Philippine Heart Center.

Methods: This is a cross sectional study. Patients who are included are those with obstructive sleep apnea diagnosed by polysomnogram aged more than 21 years old and above. Presence of metabolic syndrome and

its components were assessed among the subjects. Data are presented as mean ± sd or frequency and percent distribution.

Results: There were 77 OSA patients included in the study. Of 77 OSA patients, 40 (52%) had metabolic syndrome and 37 (48%) did not have metabolic syndrome. Patients with metabolic syndrome had larger neck and abdominal circumference compared to those without metabolic syndrome (42.11 vs. 40.83; 46 vs. 43.91). Interestingly, OSA patients without metabolic syndrome were heavier, taller and had greater BMI (33.68 vs 32.31) than those without metabolic syndrome. Hyperglycemia, dyslipidemia, and hypertension were higher among patients with metabolic syndrome.

Conclusion: Among patients with obstructive sleep apnea at the Philippine Heart Center, group of patients with metabolic syndrome showed a greater neck and abdominal circumference but not necessarily a heavier weight and greater body mass index in comparison to those without metabolic syndrome.

0441

STATUS OF ASSOCIATED FACTORS FOR THE OBJECTIVE SLEEP PROBLEMS AMONG OBESE POPULATIONS IN TAIWAN

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Introduction: In Taiwan, the prevalence of obesity has increased significantly in recent decades and has become an important public health issue. The aim of the present study was to investigate the association between obesity and objective sleep problems.

Methods: The study population from the Sleep Center of Chang-Bing Show-Chwan Memorial Hospital collected 1,083 adults over the age of 20. Each participant had a full diagnostic polysomnography. Adult obesity was defined according to Ministry of Health and Welfare criteria. In this cross-sectional research, descriptive analyses were used to determine the different subtypes of body mass index (BMI). We constructed multivariable logistic regression models to evaluate the adjusted associations of obesity status and the sleep problems. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated.

Results: Subject baseline age and BMI were 51.0 ± 16.2 years and 26.6 ± 4.9 kg/m², respectively. Our study shows that obesity (BMI ≥ 24 kg/m²) had a higher proportion of men and non-smoker (p < 0.05). Systolic blood pressure, diastolic blood pressure and neck circumference of obese populations were significantly greater than those of non-obese adults. Further analysis found that obesity had a significantly higher arousal index and apnea hypopnea index (AHI), but did not find total sleep time, sleep efficiency (%) and periodic limb movement were associated with obesity. The risk of severe sleep-disordered breathing (AHI score ≥ 20) was 3.21 times as high for individuals with obesity as for those without (95% CI: 2.09-4.91).

Conclusion: Our study suggests that obesity is associated with a higher risk of sleep problems, including not only arousal index but also AHI, independent of neck circumference.

0442

THE CORRELATION BETWEEN MATERNAL URINARY 8-HYDROXYDEOXYGUANOSINE AND GLUCOSE METABOLISM

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Introduction: Short sleep duration is associated with diabetes and pregnancy morbidity. Research in animal models has described a link

between diabetes mellitus and elevated 8-hydroxydeoxyguanosine (8-OHdG), a biomarker of oxidative damage to DNA. We sought to evaluate the correlation between gestational diabetes (GDM) and 8-OHdG levels in maternal urine and umbilical cord blood (UCB) in term pregnant women with short sleep duration.

Methods: A nested case cohort study was performed of term pregnancies enrolled in a prospective sleep disorders protocol. Subjects completed validated sleep questionnaires to assess for hypersomnolence and sleep duration. SSD was defined as ≤ 5 hours per night of sleep along with an abnormal sleep survey. Maternal urine and UCB was collected, stored at -80°C , and analyzed in duplicate for levels of 8-OHdG. Statistical analysis was performed using chi square, Man Whitney U and Spearman correlation. $P < 0.05$ was considered significant.

Results: The cohort included 64 women and 32% had SSD. Comorbid conditions included obesity (38%), GDM (6%), gestational hypertension (3%), and chronic hypertension (3%). There was no significant correlation between 8-OHdG levels in UCB samples and maternal urine samples ($r = -0.078$, $p = 0.63$). The maternal urinary levels of 8-OHdG were similar between women with and without short sleep duration ($29,400 \pm 6,426$ vs $30,977 \pm 11,110$ ng/mL, $p = 0.29$). Women with GDM had a higher umbilical cord 8-OHdG than women without GDM ($18,298 \pm 7,865$ vs $12,092 \pm 4,004$ ng/mL, $p = 0.008$). A positive correlation between glucose values on the 1 hour oral glucose tolerance test (OGTT) and levels of umbilical cord 8-OHdG ($r = 0.53$, $p = 0.02$) was noted but the correlation between glucose values and maternal urinary 8-OHdG ($r = 0.39$, $p = 0.09$) did not reach statistical significance.

Conclusion: In our cohort, GDM but not SSD was associated with elevated levels of 8-OHdG in UCB but not maternal urinary samples. Further investigations are needed to identify the mechanisms leading to adverse pregnancy outcome among women with SSD.

Support (If Any): NIH-UL1 RR024989.

0443

OUTCOMES IN PATIENTS WITH IMPAIRED PULMONARY FUNCTION AND OBSTRUCTIVE SLEEP APNEA: A RETROSPECTIVE CHART REVIEW

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Introduction: There is scarce information on the impact of abnormal pulmonary function tests (PFT) on mortality in patients with obstructive sleep apnea (OSA). We therefore decided to assess if there are any differences in the mortality of patients with restrictive, obstructive or mixed pulmonary disorders who also have OSA.

Methods: Patients with OSA confirmed by polysomnogram (PSG) who also had PFTs within 1 year of having a PSG were identified using our electronic medical records from August of 2005 to September of 2010. Demographics, apnea-hypopnea index (AHI), Charlson comorbidity index, right ventricular systolic pressure (RVSP) and ejection fraction (EF) were also collected. Survival was determined by chart review and analyzed by cox-proportional hazards models.

Results: Of the 249 patients, there were 137 (55%) females, 112 (45%) males, 164 (66%) Caucasians, and 85 (34%) African Americans. PFTs were normal in 79 (32%), obstructive in 70 (28%), restrictive in 50 (20%), and mixed in 51% (20%) of patients. Compared to those with normal PFTs, survival was worse in subjects with pure obstructive PFTs (Hazard ratio 11.8, $p = 0.02$) and those with mixed disorder PFTs (Hazard ratio 11.1, $p = 0.02$). However, in a cox-proportional model additionally incorporating the age, gender, AHI, Charlson index, RVSP and EF, only the Charlson Comorbidity Index ($P = 0.02$) and RVSP ($P < 0.001$) remained significant and independent predictors of survival.

Conclusion: In patients with OSA and impaired pulmonary function, the overall survival is a reflection of the morbidity captured by the

Charlson Comorbidity Index and the RVSP, rather than the severity of the sleep apnea or the type of ventilatory defect on the PFT.

0444

LINGUA-EPIGLOTTIS POSITION PREDICTS GLOSSOPHARYNGEAL OBSTRUCTION IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA HYPOPNEA SYNDROME

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Introduction: To investigate the relationship between lingua-epiglottis position and glossopharyngeal obstruction in patients with obstructive sleep apnea hypopnea syndrome (OSAHS).

Methods: 104 patients with OSAHS diagnosed by polysomnography (PSG) were enrolled. Lingua-epiglottis position was visualized using endoscopy and classified into three types. Spiral CT imaging of the upper respiratory tract was performed to measure the cross-sectional area and inner diameter of the glossopharyngeal airway. The PSG was repeated after the nasopharyngeal tube insertion (NPT-PSG). The NPT-PSG results, CT measured data and incidence of stenosis were compared among the different lingua-epiglottis positions groups.

Results: OSAHS patients with different lingua-epiglottis positions had similar demographics. As lingua-epiglottis position type varied from type I to type III, cross-sectional area and inner diameter of the glossopharyngeal area decreased, glossopharyngeal airway stenosis rate increased, and apnea hypopnea index (AHI) measured by NPT-PSG increased, Lowest oxygen saturation (LaSO_2) decreased.

Conclusion: Lingua-epiglottis position was significantly related to glossopharyngeal obstruction. Lingua-epiglottis position should be used in clinical practice for the preliminary assessment of glossopharyngeal obstruction.

0445

ASSOCIATIONS OF SEDENTARY TIME AND MODERATE-VIGOROUS PHYSICAL ACTIVITY WITH SLEEP-DISORDERED BREATHING

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Introduction: Accumulating evidence suggests that moderate- and vigorous-intensity physical activity (MVPA) may be protective against sleep-disordered breathing (SDB). Although daily sedentary time is associated with numerous adverse health outcomes independent of MVPA, little is known regarding its association with SDB. The aim of this study was to evaluate the relationship between sedentary time, MVPA, and SDB severity.

Methods: 119 adults (67% female, 60.3 ± 9.1 yr, body mass index [BMI]: 30.6 ± 6.2 kg/m²) participated in the study. Participants provided daily estimates of time spent in light-, moderate-, and vigorous-intensity activity for 6-14 days (mean: 9.8 ± 1.8 days). Sedentary time was calculated as the amount of time each day spent awake and not in light-, moderate-, or vigorous-intensity activity. Daily values for moderate- and vigorous-intensity activity were combined to provide an estimate of MVPA. SDB was assessed from one night of laboratory polysomnography. All analyses adjusted for age, BMI, race, and sex.

Results: The mean apnea-hypopnea index (AHI) for the sample was 9.2 ± 13.1 , with 18% having at least moderate-severity SDB ($\text{AHI} \geq 15$). Participants reported 13.7 ± 2.2 hr/day of sedentary time and 47.1 ± 49.8 min/day of MVPA. In separate models, adults with high sedentary time (i.e., above-median; > 13.8 hr/day) had significantly greater AHI compared to adults with low sedentary time (8.8 ± 2.9 vs. 3.4 ± 3.1 ; $P = .02$), and adults with high MVPA (> 37 min/day) had significantly lower

AHI compared to adults with low MVPA (3.5 ± 3.2 vs. 8.3 ± 2.9 ; $P = .05$). When considered together in the same model, adults with a combination of high sedentary time and low MVPA had significantly higher AHI than all other groups ($P < .01$).

Conclusion: Independent of BMI, both sedentary time and MVPA were associated with SDB. Whether reducing sedentary time could lead to lower SDB severity deserves future exploration.

Support (If Any): Research support provided by R01 HL104607 and T32 HL082610.

0446

DIFFERENTIAL PREVALENCE OF OSA COMORBIDITIES AS A FUNCTION OF AGE AND GENDER

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Introduction: Obstructive sleep apnea (OSA) is associated with a variety of medical and psychiatric comorbidities. Moreover, there are known age- and gender-related differences in clinical features of OSA as well as the comorbidities. The present research aims to identify effects of age and gender risk factors for the development of specific OSA related morbidities.

Methods: Medical records were evaluated to identify 100 patients (49F, age 54.98 ± 7.39 yrs) with OSA who underwent a diagnostic polysomnogram for OSA at a metropolitan academic sleep center. OSA was defined as apnea-hypopnea index (AHI) $> 5/h$. Analyses were stratified by age and gender: younger males (< 55 years), older males (≥ 55), younger females (< 55 years) and older females (≥ 55 years). Information was obtained on demographic, medical, sleep and polysomnographic variables for all patients. A two-factor (age and gender) ANOVA analyzed evaluated their contribution to the following comorbidities: hypertension, diabetes, coronary artery disease (CAD), depression, chronic pain, and insomnia.

Results: There was no main effect of gender or age on the prevalence of any of the comorbid conditions. There was a significant interaction for prevalence of CAD ($F(2.36, 59)$, $p = .003$) indicated that CAD prevalence was significantly increased in older males.

Conclusion: These data suggest that obstructive sleep apnea is associated with an increased differentially elevated risk of CAD among older men.

0447

SLEEP APNEA DEVELOPED YOUNGER, COMPLICATED WITH ALLERGIC RHINITIS

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Introduction: The object of this study was to evaluate the effects of allergic rhinitis (AR) on sleep apnea syndrome.

Methods: Data from 75 outpatients who had sleep trouble and consulted the sleep apnea clinic in the otolaryngology department of our hospital between November 2011 and October 2012 was utilized. They were arranged into 4 specific groups (with seasonal AR, with perennial AR, with both types of AR, and without AR). This study was analyzed using the Mann-Whitney U-test.

Results: 34% were without AR and 66% people were with complicated AR (49/74), including 51% (25/49) with both perennial and seasonal of AR, 37% (18/49) with only seasonal AR and 12% (6/49) with only perennial AR. Total serum IgE measured by the RIST (radioimmunosorbent test) of people with both types of rhinitis were higher than the other groups ($p < 0.05$). Moreover, the age of the patients with both types of rhinitis was lower than the age of those without it ($p < 0.05$). Although

the AHI of patients without rhinitis was higher than the AHI of those with seasonal rhinitis ($p < 0.05$), the AHI of non-rhinitis patients was not much different from the patients with both types of rhinitis. And more, the age of the high AHI (over 40) patients with both types of rhinitis was lower than the age of those without it ($p < 0.05$).

Conclusion: The inflammation (reflected by high RIST values) caused by AR may lead those with perennial and seasonal AR to develop sleep apnea at a younger age than those without AR. Sleep apnea can take a turn for the worse when complicated with severe AR. It is thought that nasal mucosal hypertrophy due to the inflammation of severe allergic rhinitis causes nasal obstruction, thereby worsening the symptoms of sleep apnea.

0448

ETHNIC AND GENDER VARIATIONS IN THE PREVALENCE OF NOCTURNAL GASTROESOPHAGEAL REFLUX AND ITS ASSOCIATED SYMPTOMS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Nocturnal gastroesophageal reflux disease (GERD) is associated with the presence of obstructive sleep apnea (OSA). Prior studies in restricted populations have shown males, Caucasians, and older patients are at higher risk for nocturnal GERD. The purpose of this study was to evaluate the prevalence of nocturnal GERD in a population with OSA, and its association with other sleep-related symptoms.

Methods: A retrospective chart review was performed of patients referred for suspected OSA. All patients completed a sleep questionnaire prior to undergoing polysomnography. Fifty consecutive records in each demographic category (Caucasian males, African American males, Hispanic males, Caucasian females, African American females, and Hispanic females) with confirmed OSA were selected for review. Associations were determined between nocturnal GERD and daytime sleepiness, insomnia, restless legs symptoms, and markers of OSA severity.

Results: There was no difference in the prevalence of nocturnal GERD between gender or ethnic groups. The Epworth Sleepiness Scale score was significantly higher in all participants ($P = 0.020$), males ($P = 0.040$), and African Americans ($P = 0.002$) with GERD than those without GERD. Nocturnal GERD was associated with insomnia complaints in all subjects ($P = 0.007$), females ($P = 0.004$), and African American females ($P = 0.02$). GERD and restless legs symptoms were significantly correlated in all participants ($P = 0.039$), Caucasians ($P = 0.015$), and Caucasian females ($P = 0.005$). Nocturnal GERD demonstrated a positive correlation with AHI in African American males ($P = 0.039$), and a negative correlation with SaO_2 nadir ($P = 0.043$).

Conclusion: Nocturnal GERD is common in patients with OSA. Associated symptoms, such as insomnia and restless legs, may also require treatment. Understanding differences in presentation among gender and ethnic groups may help providers more effectively treat a variety of patient populations.

0449

SYMPTOMS RELATED TO SLEEP BRUXISM DIFFER BY ETHNICITY AND GENDER IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Sleep bruxism is associated with the presence of obstructive sleep apnea (OSA); prior data has demonstrated that the prevalence differs among gender and ethnic groups. The purpose of this study was to evaluate other associated sleep-related symptoms in these patients.

Methods: A retrospective chart review was performed of patients seen at the Baylor College of Medicine Sleep Center in Houston, TX. All patients completed a comprehensive sleep questionnaire prior to undergoing polysomnography. Fifty consecutive records in each demographic category (Caucasian males, African American males, Hispanic males, Caucasian females, African American females, and Hispanic females) with OSA (apnea-hypopnea index ≥ 5) were selected for review. Associations were determined between sleep bruxism and nocturnal gastroesophageal reflux disease (GERD), daytime sleepiness and markers of OSA severity.

Results: Sleep bruxism was associated with nocturnal GERD in all participants ($p = 0.005$), females ($p = 0.011$), and African American females ($p = 0.035$). In Hispanics, bruxism was negatively correlated with insomnia complaints ($p = 0.028$). Sleep bruxism and restless legs symptoms were correlated significantly in all participants ($p = 0.011$), males ($p = 0.007$), and Caucasian males ($p = 0.011$). The Epworth Sleepiness Scale score was higher in African Americans with sleep bruxism than those without (16.0 ± 5.8 vs. 13.1 ± 6.2 , $p = 0.036$).

Conclusion: Sleep bruxism can present in conjunction with other sleep disorders, often requiring special attention. Differences in symptom presentation between ethnic and gender groups can make identification of these sleep disorders more difficult. Knowledge of these differences may lead to identification of underlying pathophysiologic mechanisms and help providers tailor appropriate treatment.

0450

SLEEP STRUCTURE AND CONTINUITY IN SLEEPY AND NON-SLEEPY PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is generally defined as the confluence of sleep disordered breathing (SDB) and excessive daytime sleepiness. However, there is only a poor correlation between severity of SDB and severity of daytime sleepiness. We hypothesized that sleep is more disrupted in sleepy patients compared to non-sleepy patients with similar severity of SDB.

Methods: Subjects with symptoms of SDB and no other sleep disorder had a full night PSG, followed by daytime function testing. AHI4% and AHI3%-plus-arousals [RDI] were determined. Mild-moderate OSA was defined as AHI4% > 5 or RDI > 15 , and AHI4% < 30 ($n = 42$, aged 48.3 ± 11.7); severe OSA was AHI4% > 30 ($n = 38$, aged 46.9 ± 12.2). Each of the groups were divided into sleepy and non-sleepy groups by multiple criteria: cut points were 10 for ESS, 15 for FOSQ, 8 for MSLT and 3 for PVT transformed lapses. We compared sleepy and non-sleepy subjects by each metric of daytime function for standard sleep variables, AHI4% and RDI. Survival curves of continuous

sleep segments (continuity) were also compared between sleep and non-sleepy subjects.

Results: In both mild-moderate and severe OSA groups, there were no significant differences in SDB indices, TST, sleep architecture, sleep efficiency between sleepy and non-sleepy. In mild-moderate OSA, sleep was less continuous in sleepy than non-sleepy only when assessed by MSLT ($p = 0.0001$). In severe OSA, sleep was less continuous in sleepy than non-sleepy assessed by FOSQ ($p = 0.002$) but more continuous when assessed by ESS ($p = 0.001$).

Conclusion: For similar levels of SDB, in both mild-moderate and severe OSA patients, sleepy and non-sleepy patients differed only in some measures of sleep continuity. It is unclear why in severe OSA continuity was unexpectedly better in sleepy (by ESS) subjects. These results suggest that for a given level of SDB, the difference in sleep structure between sleepy and non-sleepy subjects is better shown by continuity than conventional sleep measures.

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0451

IS THE SLEEP DEFICIT IN DEMENTIA CAREGIVERS DUE TO UNDIAGNOSED SLEEP APNEA?

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Introduction: While researchers have consistently found poor sleep quality in caregivers of persons with dementia (CGofPWD), the differences are mixed in qualitatively or quantitatively measured sleep. A proposed explanation is a higher rate of sleep disordered breathing (SDB) in CGofPWD. The purpose of this study was to compare the sleep of CGofPWD with/without SDB.

Methods: CGofPWD with sleep complaints were recruited as a part of a larger trial and the baseline data will be analyzed to compare participants with SDB with caregivers with no or mild SDB. Actigraphic and sleep diary data were collected for 14 consecutive days as well as demographics, depression scores and data on purpose of CGofPWD awakenings. A Type III home sleep test was conducted prior to sleep data.

Results: Preliminary analyses of this ongoing study were completed using the first 19 participants. All caregivers had poor sleep but group differences were small as displayed below (sample mean in minutes/group mean difference in minutes -noSDB-SDB): total sleep time = 371 / +4; total waketime = 125 / +6; sleep efficiency = 75 / < 1. On examination of wake after sleep onset, 49.4% (30 / +18) was spent on caregiving activities and 51.9% (31 / -8) was spent on personal activities.

Conclusion: Preliminary analyses of this ongoing study were completed using the first 19 participants. All caregivers had poor sleep but group differences were small as displayed below (sample mean in minutes/group mean difference in minutes -noSDB-SDB): total sleep time = 371 / +4; total waketime = 125 / +6; sleep efficiency = 75 / < 1. On examination of wake after sleep onset, 49.4% (30 / +18) was spent on caregiving activities and 51.9% (31 / -8) was spent on personal activities.

Support (If Any): Funding was provided by NIA grant 5R01AG039495-03.

0452

SEX DIFFERENCES IN THE RELATIONSHIP BETWEEN OBSTRUCTIVE SLEEP APNEA (OSA) AND INSOMNIA SEVERITY IN A COMMUNITY- AND CLINIC-BASED SAMPLE

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Introduction: Research has demonstrated that insomnia is common among patients referred for apnea treatment. However, few studies have explored this co-morbidity in community-based samples. Furthermore, given sex differences in the prevalence of apnea and insomnia, sex differences in the relationship between these conditions are likely. The current study examined sex differences in the relationship between apnea and insomnia severity in community- and clinic-based samples.

Methods: The community sample was drawn from the Wisconsin Sleep Cohort Study and included 1535 studies on 755 individuals who had completed overnight polysomnography (PSG) and an insomnia questionnaire. The clinical sample included 456 consecutive patients who underwent PSG for suspected OSA, had an AHI > 5, and completed the Insomnia Severity Index. Participants' apnea was classified as mild (AHI > 5 and = 15 and = 30). The community sample had a comparison group of those without apnea (AHI < 5).

Results: Using a continuous insomnia model testing the interaction between sex and apnea severity (adjusted for age and body mass index), results revealed a significant interaction between sex and apnea severity for both samples ($p < .05$). In sex-stratified models for the community sample, for men, insomnia symptoms increased with greater apnea severity, whereas, for women, insomnia symptoms decreased with greater apnea severity (both $p < .05$). A similar pattern emerged in the clinical sample with insomnia severity decreasing with greater apnea severity for women ($p = .05$); however, for men, insomnia severity remained stable with greater apnea severity.

Conclusion: The relationship between apnea and insomnia differed by sex in a community sample and was similar in a clinic sample. These findings have significant clinical implications for effective assessment and treatment of apnea and insomnia in men and women.

0453

ASSOCIATION BETWEEN URIC ACID LEVELS AND OBSTRUCTIVE SLEEP APNEA SYNDROME IN A LARGE EPIDEMIOLOGICAL SAMPLE

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Introduction: Recurrent hypoxia, which is associated with obstructive sleep apnea syndrome (OSAS), leads to an increase in the degradation of adenosine triphosphatase into xanthine, which in turn increases uric acid concentrations. The current study aimed to determine whether an association exists between OSAS and uric acid levels in the peripheral blood from a representative population of São Paulo (Brazil).

Methods: A population-based survey adopting a probabilistic 3-stage cluster sample of São Paulo was used to represent the population according to gender, age, and socioeconomic class. A total of 1,042 volunteers underwent polysomnography recordings for OSAS diagnosis, blood pressure assessment, and biochemical blood analysis, and answered questionnaires.

Results: Uric acid levels were correlated with most important risk factors for OSAS, such as AHI, desaturation time and index, minimum

oxyhemoglobin saturation (SpO₂), blood pressure, cholesterol, BMI, triglycerides and arousal, and with OSAS itself. Also, uric acid was increased in OSAS volunteers even after controlling for all confounders. Hyperuricemic volunteers presented lower mean and minimum SpO₂ and increased desaturation index. Importantly, minimum SpO₂ was a significant predictor of uric acid levels, which in turn was considered an independent predictor for OSAS in the binary logistic model. However, a ROC curve analysis for establishing cut-off points for uric acid levels as a biomarker of OSAS revealed moderate sensitivity and specificity.

Conclusion: A strong association was found between uric acid levels and OSAS in a representative sample of the population of São Paulo. Although they do not qualify for a biomarker alone, uric acid levels may be involved in OSAS severity and should be considered in sleep apnea management in the future.

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0454

SLEEP DISORDERED BREATHING IN ADVANCED HEART FAILURE SERVICE AT A TERTIARY CARE HOSPITAL

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Introduction: Sleep disordered breathing (SDB) is a common disorder. Data suggests that SDB is under-diagnosed and under-treated in hospitalized settings. We hypothesize the prevalence of sleep disordered breathing to be high in the advanced heart failure unit. We also assessed the value of inpatient overnight pulse-oximetry derived oxygen desaturations index (ODI).

Methods: All patients admitted to heart failure service between March and October of 2013 were screened with the STOP-BANG questionnaire. Based on screening and the decision of admitting physician, 43 patients were formally evaluated by the sleep program.

Results: A total of 43 (42%) of the 103 screened patients were formally evaluated and received overnight pulse oximetry as part of the evaluation. 20 of 43 (47%) also underwent overnight polysomnography post discharge. Median age of this cohort was 57 (49.5-61.5), 10 (50%) were males, median BMI was 38.0 (32.6-43.9, median EF of 35% (20%-62.5%), 8 (40%) had diabetes, 16 (80%) had hypertension. Of these patients, 17 (85%) were diagnosed with SDB (AHI > 5) based on apnea hypopnea index (AHI), 4 (20%) had severe OSA, 6 (30%) had moderate OSA and 7 (35%) had mild OSA. In 20 patients who had both in-patient ODI and outpatient AHI (PSG) median ODI was 14.0 (6.6-34.8) compared to the median AHI of 14 (5.5-27.0). The Pearson correlation coefficient was significant, suggesting a moderate linear association between log-transformed ODI and AHI (0.49, $p = 0.03$).

Conclusion: Introduction of formal sleep screening program suggests under-diagnosis of SDB in patients admitted in the advanced heart failure unit. These data also suggest inpatient ODI and AHI are significantly correlated in this cohort of patients. More data are necessary in order to detect a reliable ODI cut-point for predicting moderate-to-severe SDB.

0455

RELATIONSHIP BETWEEN NECK CIRCUMFERENCE AND POLYSOMNOGRAPHY PARAMETERS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME

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Introduction: Physical assessment hasn't shown a very strong predictive severity diagnostic value in the obstructive sleep apnea (OSA). Polysomnography is the gold standard diagnostic tool, but it is expensive and difficult to get it in some cases. Therefore it is important to find other diagnostic studies that may give us an approximation to the severity of OSA. Objective: To establish the relationship between neck circumference and polysomnography parameters.

Methods: This was a longitudinal—observational and analytic—study in a population-based prospective and protective cohort. We collected the patients with suspicion of OSA, in the otolaryngology clinics; they were assessed with the neck circumference measure and diagnostic polysomnography. We determined the independent samples t-test, and the descriptive parameters in the statistical analysis.

Results: We evaluated 141 patients, 95 males (67.4%), 46 females (32.6%), neck circumference (NC) range: 30-59 cm, NC mean 40.9 cm, 45 patients with NC greater than 43 cm and 96 patients with NC lesser than 43 cm; minimal oxygen saturation range: 35-91% with a mean of 72%; mean oxygen saturation range: 65-96% with a mean of 88.9%; apnea hypopnea index (AHI) range: 0.6-173 events/hour with a mean 52.6 events/hour. There is a statistical significance p value lesser than 0.05 between the NC greater than 43 cm and NC lesser than 43 cm group, in these parameters: minimal saturation, mean saturation and AHI.

Conclusion: The NC greater than 43 cm was associated with the worse results in the following polysomnography parameters: minimal saturation, mean saturation and AHI. These findings may give us an association between NC and the severity of the OSA.

0456

FIBROBLAST GROWTH FACTOR 21 LEVELS ARE INCREASED IN OBSTRUCTIVE SLEEP APNEA PATIENTS

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Introduction: Fibroblast growth factor 21 (FGF21), a hormone primarily secreted by the liver, has recently been shown to possess potent beneficial effects on glucose and lipid metabolism and insulin sensitivity in animal models. Serum FGF21 levels are increased in obesity, non-alcoholic fatty liver disease and are independently associated with the metabolic syndrome in humans. However, whether FGF21 levels are affected by obstructive sleep apnoea (OSA) remains unclear. The aim of this study is to investigate the association of FGF21 with OSA in Chinese patients.

Methods: Serum FGF21 levels were determined by ELISA in 360 (male 305) untreated OSA (defined as an apnea-hypopnea index [AHI] ≥ 5) and 215 (male 105) control subjects (AHI < 5), and their association with parameters of adiposity, glucose, and lipid profiles was studied.

Results: Serum FGF21 levels in patients with OSA (495.89 pg/ml [461.36, 532.45]) were significantly higher than those in control subjects (387.42 pg/ml [347.46, 430.52]) ($p < 0.001$). After adjustment for age and gender, we found a significant positive association of serum FGF21 levels with BMI and neck circumference (all $p < 0.05$). After

adjustment for age, gender, and BMI, serum FGF21 correlated positively with OSA parameters (AHI and ODI), total cholesterol, triglyceride, fasting glucose, fasting insulin, HOMA-IR, and hsCRP (all $p < 0.05$). A negative association FGF21 and HDL-C levels was also observed ($p < 0.001$). Stepwise multiple linear regression analysis showed that triglyceride and CRP were found to be independently associated with serum FGF21 (all $p < 0.05$).

Conclusion: In a large unselected OSA population, FGF21 was increased in subjects with obstructive sleep apnea, independent of obesity.

0457

THE BERLIN QUESTIONNAIRE DOES NOT IDENTIFY OBSTRUCTIVE SLEEP APNEA SYNDROME (OSAS) RISK AMONG PATIENTS WITH MODERATE-SEVERE GASTROESOPHAGEAL REFLUX DISEASE (GERD) REFRACTORY TO PROTON PUMP INHIBITOR (PPI) TREATMENT

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Introduction: Sleep disturbances are common in patients with GERD. OSAS and GERD share risk factors and often coexist. The Berlin Questionnaire has been useful for assessing OSAS risk in patient groups with associated medical disorders. We examined the frequency of polysomnography (PSG) diagnosed OSAS among moderate-severe, PPI-refractory GERD patients screened to be at high risk by the Berlin Questionnaire.

Methods: Patients referred to a GI clinic for PPI-refractory GERD were recruited for a pilot study of a clinical trial of CPAP for nocturnal GERD symptoms. Patients were screened for inclusion/exclusion by telephone. At the intake visit, they completed instruments measuring GERD severity and sleep disturbance and were screened for OSAS risk by the Berlin Questionnaire (≥ 2 categories positive). PSG was done within 2 months.

Results: 19 patients (16 women) were included (mean \pm SD): age 46 ± 13.0 yr; BMI 29.2 ± 4.9 ; neck circumference 14.6 ± 1.4 in; waist circumference 39.3 ± 4.5 in. Severity scores were high on the GERD Symptom Assessment Scale (GSAS) (2.49 ± 1.67) and Nocturnal GERD Symptom Severity and Impact Questionnaire (N-GSSIQ) (2.73 ± 0.99). Medical Outcomes Sleep Scale (MOS-12) scores indicated that most had sleep disturbances with reduced average sleep quantity (5.7 ± 1.9 hr) and "optimal sleep" (32%). The Berlin Questionnaire indicated high OSAS risk in 16/19 (84%) patients. PSGs done in 11 showed apnea-hypopnea index: > 5 in 2 (18%), 0.1-4 in 2 (18%) and 0 in 7 (64%). All Berlin Questionnaire questions except 6 (quit breathing during sleep) and 9/9A (nod off while driving) had $> 50\%$ positive responses. There was high correlation between OSAS risk by Berlin Questionnaire and MOS-12 "sleep problem" scales ($R = 0.71$, Spearman rank order correlation $p < 0.001$). Correlation was not significant for Berlin Questionnaire risk vs GSAS and N-GISSQ scores.

Conclusion: Screening by the Berlin Questionnaire in PPI-refractory GERD patients may not distinguish OSAS risk from GERD-related sleep disturbance.

Support (If Any): Olive View Educational and Research Institute.

0458

SLEEP APNEA IS A MAJOR RISK FACTOR FOR CAROTID ARTERIOSCLEROTIC DISEASE SEVERITY*Ehrhardt J, Schwab M, Witte OW, Rupprecht S*

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Introduction: Carotid arteriosclerosis and sleep apnea are independent risk factors for stroke. However, whether carotid stenosis severity is mediated by sleep apnea remains unclear. Sleep apnea comprises two distinct pathophysiological conditions: obstructive (OSA) and central sleep apnea (CSA). Whilst OSA is the consequence of upper airway occlusion, CSA reflects carotid chemoreceptor dysfunction.

Methods: Ninety-six patients with asymptomatic extracranial carotid stenosis of $\geq 50\%$ underwent polysomnography to determine, I) prevalence and severity of sleep apnea in different degrees of carotid stenosis, and, II) direct and indirect effects of OSA and CSA on carotid stenosis severity.

Results: Sleep apnea was present in 68.8% of patients with carotid stenosis. Prevalence and severity of sleep apnea increased with degree of stenosis ($P \leq 0.05$) due to a rise in CSA ($P \leq 0.01$) but not in OSA. Sleep apnea (OR, 3.8, $P \leq 0.03$) and arterial hypertension (OR, 4.1, $P \leq 0.05$) were associated with stenosis severity whereas diabetes, smoking, dyslipidemia, BMI, age and sex were not. Effects of sleep apnea on stenosis severity were mediated by CSA ($P \leq 0.06$) but not by OSA. CSA but not OSA showed a strong association with arterial hypertension (OR, 12.5, $P \leq 0.02$) and diabetes (OR, 4.5, $P \leq 0.04$).

Conclusion: Sleep apnea, highly prevalent in carotid stenosis, represents a major risk factor for carotid arteriosclerotic disease. Increased vascular risk is mediated by CSA due to carotid chemoreceptor dysfunction owing to direct and indirect effects. Indirect effects are attributed to augmentation of arterial hypertension and diabetes. Since sleep apnea is treatable, screening should be embedded in stroke prevention strategies.

Support (If Any): The study was supported by the Reinhard Loewenstein Foundation.

0459

SLEEP ARCHITECTURE FOLLOWING A WEIGHT LOSS INTERVENTION IN OVERWEIGHT AND OBESE PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND TYPE 2**DIABETES: RELATIONSHIP TO APNEA-HYPOPNIA INDEX***Shechter A^{1,2}, St-Onge M^{1,2}, Kuna ST³, Zammit G⁴, RoyChoudhury A¹, Newman AB⁵, Millman RP⁶, Reboussin DM⁷, Pi-Sunyer F^{1,2}, Foster GD⁸*

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Introduction: Obese individuals with type 2 diabetes (T2D) show a high prevalence of obstructive sleep apnea (OSA), and an intensive lifestyle intervention (ILI) reduced body weight and apnea-hypopnea index (AHI) in these patients. Since sleep can influence energy balance, we aimed to determine if the ILI affected sleep architecture, and explored the relationship between AHI and sleep architecture.

Methods: Participants in the Look AHEAD trial were randomized to the ILI, comprising a behavioral weight loss program, or the diabetes support and education (DSE) control. Participants in the current report included 264 overweight/obese adults with T2D and OSA enrolled in the ancillary Sleep AHEAD study. Measures included one night of in-

home polysomnography, including airflow measurements via nasal pressure cannula and oronasal thermistor, weight, and neck circumference at baseline and y-1, y-2, and y-4 follow-ups. Mixed-model analyses, adjusted for sex, age, race, and treatment site, were used to compare between-group differences in change-from-baseline for sleep measures, and to assess the relationship between sleep parameters and AHI, weight, and neck circumference for all participants together.

Results: There were no between-group differences in change-from-baseline for sleep duration, stage 1, stage 2, slow wave sleep, or rapid-eye movement (REM) sleep at y-1, y-2, or y-4. Collapsing across groups, there was a negative association between changes in AHI and stage 2 ($p = 0.001$) and REM sleep ($p < 0.001$), and a positive association between changes in AHI and stage 1 sleep ($p < 0.001$), but no relationship between weight changes and sleep architecture.

Conclusion: The ILI did not induce changes in sleep architecture different than DSE. In participants overall, greater reductions in AHI over the follow-up were associated with greater increases in stage 2 and REM sleep, and greater decreases in stage 1 sleep, suggesting that reducing OSA severity may improve sleep quality.

Support (If Any): HL070301; DK60426; DK56992; DK057135; DK007559.

0460

EXPIRATORY PALATAL OBSTRUCTION WITH OBSTRUCTIVE OR CENTRAL APNEAS*Park SY^{1,2}, Pillai S¹*

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Introduction: Obstructive events during apneas typically occur during the inspiratory phase. Central apneas are commonly seen with neurologic conditions or heart failure. We present a series of relatively healthy patients with expiratory apneas due to possible palatal obstruction, which can sometimes mimic central apneas.

Methods: Retrospective review of eight patients with obstructive sleep apnea (OSA) with clinical suspicion for expiratory apneas, and various degrees of central apneas, who underwent clinical evaluation and overnight polysomnography.

Results: Eight patients with a median age of 36 years (3-53 years), BMI of 25.7 ± 5.6 and AHI of 26.4 ± 22.4 were studied. One pregnant patient exhibited sudden mid-exhalation breathing pauses starting with a light flapping noise, breath holding for 5 to 10 seconds, sudden exhalation out through the mouth, a few cycles of hyperventilation, and repeated breath holding episodes. This resolved postpartum. Video of expiratory palatal obstruction was documented in two patients. One of these patients had complete resolution after palatal surgery. Four patients had history suggestive of REM-related central events, with two of these four patients documenting central events only in stage REM. In three patients, cardio-ballistic oscillations were not seen in the nasal channel, implying obstructed breathing. Four patients endorsed moaning. In one of these patients, moaning resolved partially after surgery.

Conclusion: Expiratory apneas have been described in the literature. The findings presented in this study suggest that palatal obstructions during nasal exhalation can be mistakenly scored as central apneas. Classic central apneas are seen in lighter stages of non-REM sleep, particularly after arousals or sleep stage changes. Two patients in our series had central events only in stage REM. Polysomnography revealed tracings typical for central apneas, including flat nasal, oral, chest and abdominal signals for more than 10 seconds. These events begin mid-exhalation, ending with sudden oral exhalation. Vocalization during central apneic episodes can also occur. Shorter pauses may lead to symptomatic obstructions and arousals, with many of these events being scored as a RERA or an arousal. Expiratory palatal apneas must be considered in

healthy, younger individuals with central apneas of unclear etiology. Catathrenia can also possibly be explained by expiratory palatal obstruction. A thorough history and physical examination must be undertaken to look for the presence of expiratory soft palatal obstruction during nasal exhalation.

0461

THE INFLUENCE OF CO₂ ON GENIOGLOSSUS MUSCLE ACTIVITY FOLLOWING AROUSAL IN OBSTRUCTIVE SLEEP APNEA PATIENTS

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Introduction: The ventilatory response to arousal in obstructive sleep apnea (OSA) is hypothesised to predispose to further obstruction by inducing hypocapnia and a subsequent reduction in upper airway dilator muscle activity on return to sleep. However, prior studies have not found dilator muscle activity to be reduced following arousal. A limitation of these studies is that CO₂ was not consistently reported. As hypocapnia is central to the arousal hypothesis, we aimed to determine whether reduced CO₂ following arousal is associated with reduced dilator muscle activity on the return to sleep.

Methods: Data has been obtained in 7 OSA patients who slept untreated whilst instrumented with EEG, EOG, EMG and intramuscular genioglossus (EMGgg) electrodes; epiglottic pressure catheter (Pepi) and partial pressure of end-tidal CO₂ (PetCO₂) monitoring. Post-study, NREM respiratory arousals were categorised by the level of PetCO₂ on the last breath of the arousal immediately before the return to sleep, relative to waking baseline PetCO₂. Arousals 0-3 mmHg less than waking PetCO₂ were categorised as “low” CO₂. Arousals 0-3 mmHg more than waking PetCO₂ were categorised as “high” CO₂. The respiratory and muscle data on return to sleep was compared using a two-way repeated measure ANOVA (breath-first five breaths of sleep onset) × (PetCO₂ Condition-low vs. high).

Results: There were 149 and 87 arousals in the low and high conditions respectively. By design, PetCO₂ on the last breath of arousal was significantly less in the low condition than the high condition (39.6 ± 2.3 vs. 41.4 ± 2.3 , $p = .01$). No variable differed between PetCO₂ conditions, including EMGgg. There were significant breath effects with both Vi and Pepi declining following sleep onset.

Conclusion: These early results suggest that low CO₂ following arousal does not reduce dilator muscle activity on return to sleep as is suggested by the current arousal hypothesis. Data collection is ongoing.

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0462

DISTURBED SLEEP IN OBESE INDIVIDUALS: WHAT IS THE ROLE OF OSA?

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Introduction: Disturbed sleep has been reported in obese individuals but it is unclear whether OSA is primarily responsible for this poorer sleep quality. Our aim was to investigate sleep architectural changes associated with obesity in patients with and without OSA.

Methods: We retrospectively evaluated polysomnographic data from patients scheduled for bariatric surgery. Those with a previous diagnosis

of obstructive sleep apnea (OSA) and/or on continuous positive airway pressure therapy were excluded.

Results: Study patient characteristics were as follows: 64% males; BMI 49.2 ± 8.9 ; 82% (187/227) diagnosed with OSA. Patients were divided into 4 groups based on the presence/severity of OSA: Group 1, AHI < 5 ($n = 40$); Group 2, AHI ≥ 5 , < 15 ($n = 66$); Group 3, AHI ≥ 15 , < 30 ($n = 36$); Group 4, AHI ≥ 30 ($n = 85$). The average BMI was above 44 kg.m² in all study groups but patients with AHI < 5 had a slightly lower BMI ($p < 0.001$) and were significantly younger ($p = 0.021$). Overall, study patients had a decreased total sleep time (TST; 344 ± 98.8 minutes), increased wakefulness (% Wake; $20.0 \pm 29.2\%$), decreased rapid eye movement sleep (% REM; $11.8 \pm 7.2\%$), and reduced sleep efficiency (SE; $75.4 \pm 17.5\%$). There were no differences in TST, % Wake, % REM or SE across the 4 patient groups. Patients with AHI < 5 were found to have an elevated arousal index (AI; 21.7 ± 11.1) and an increased frequency of leg movements during sleep (PLMi; 8.7 ± 14.4).

Conclusion: Our study suggests that obese patients undergoing bariatric surgery have altered sleep architecture, in particular, with shortened sleep duration, increased wakefulness and low sleep efficiency. OSA was not primarily responsible for this disturbed sleep as the degree of sleep disruption was similar for those with and without a diagnosis of OSA. Given the negative impact of poor sleep on metabolic indices, in addition to screening for OSA, patients undergoing bariatric surgery should be routinely assessed for sleep disturbances.

0463

AUTOBIOGRAPHICAL MEMORY BIAS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is associated with higher rates of depression and mood disturbance, and memory impairments. Recent studies have linked overgeneral autobiographical memory (AM) with the course of depression in depressed OSA patients. It is unclear whether overgeneral AM is specifically linked to depression in OSA patients, or whether it is also observed in OSA patients without depression, as a result of their sleep disturbance. This study aimed to examine whether AM overgenerality is observed in OSA patients, both with and without comorbid depressive symptoms.

Methods: Seventeen moderate to severe OSA patients (mean AHI = 28.63 events/hr; age = 42.23 years), 10 of whom had significant depressive symptoms (Center for Epidemiology Studies - Depression (CES-D) score > 16), and 18 healthy controls (mean AHI = 0.13 events/hr; age = 31.61 years) completed the AM Test, which assessed specific memory generation for 6 positive and 6 negative cue words.

Results: Preliminary data indicated that the OSA patients with depressive symptoms recalled significantly more overgeneral memories compared to healthy controls ($p = 0.001$). There was also a trend-level increase in overgeneral AM recollection in OSA patients without depression compared to healthy controls ($p = 0.053$), however no difference was observed between the two patient groups ($p = 0.10$). CES-D scores did not significantly correlate with AM overgenerality across all OSA patients.

Conclusion: These data support previous studies findings of increased overgeneral AM in OSA patients with depressive symptoms. While more data is needed to confirm the current findings in non-depressed OSA patients, altered AM may also be a result of sleep disruption experienced by these patients, which in turn may increase their susceptibility of developing mood disturbance over time.

Support (If Any): National Health and Medical Research Council Early Career Fellowship; University of Melbourne Early Career Research Grant.

0464

COMORBID INSOMNIA AND SLEEP APNEA: COMPLEX RELATIONSHIPS WITH DAYTIME FATIGUE AND SLEEPINESS*Wohlgemuth W¹, Tetali P², Wallace D²*¹Psychology Service (116B), Miami VA Sleep Center, Miami, FL, USA, ²Miami VA Sleep Disorders Center, Miami, FL, USA

Introduction: Fatigue and sleepiness are two commonly reported daytime symptoms of insomnia and sleep apnea. Little has been reported on the relative contributions of insomnia and sleep apnea to each of these symptoms in co-morbid insomnia/OSA patients. We expected that nighttime symptoms of insomnia and sleep apnea would be positively related to daytime symptoms of fatigue and sleepiness.

Methods: Participants were 440 veterans who attended the Miami VA Sleep Center for evaluation and treatment of OSA. Veterans completed a battery of questionnaires including the Epworth Sleepiness Scale, the Insomnia Severity Index and the Fatigue Severity Scale prior to initiating CPAP. Medical/psychiatric conditions as well as PSG results was extracted from the medical record. A structural equation model with latent variables was constructed and was tested in Mplus. Sleepiness and fatigue were regressed on nighttime symptoms of insomnia and OSA while controlling for psychiatric and medical comorbidities, BMI and age. Structural equations allow for all predictors and outcomes to be considered simultaneously.

Results: Strong statistical support was provided for the hypothesized model (ChiSq = 579.96, df = 302; RMSEA = 0.046; CFI = 0.953, SRMR = 0.048). Path coefficients indicated that nighttime insomnia symptoms were positively associated with daytime sleepiness (beta = .235, $p < .001$), but OSA was not (beta = .021, $p = .750$). Insomnia was also positively associated with daytime fatigue (beta = .332, $p < .001$). Unexpectedly, OSA was negatively associated with daytime fatigue (beta = -.159, $p = .010$). That is, higher levels of OSA were related to lower levels of fatigue.

Conclusion: As expected, nighttime insomnia symptoms were positively associated with daytime fatigue and sleepiness. However, surprisingly, sleep apnea was not associated with daytime sleepiness and was inversely related to daytime fatigue in a well-controlled model. Further exploration of the complex relationship between OSA and daytime symptoms seems warranted.

0465

LEFT VENTRICULAR DIASTOLIC DYSFUNCTION IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME*Noda A¹, Miyata S¹, Otake H²*¹Chubu University, Kasugai, Japan, ²Nagoya University Graduate School of Medicine, Nagoya, Japan

Introduction: Obstructive sleep apnea syndrome (OSAS) is linked to hypertension, ischemic heart disease, and cardiac arrhythmias. Successful continuous positive airway pressure (CPAP) treatment has a beneficial effect on hypertension and improves the survival rate of patients with cardiovascular disease. The possible effect of OSAS on the left ventricular (LV) diastolic function, however, has been unclear. Strain rate (SR) imaging based on tissue Doppler imaging (TDI) is a newly developed echocardiographic modality that allows quantitative assessment of regional myocardial wall motion. TDI is a validated echocardiographic technique that can appropriately assess systolic and diastolic myocardial function as well as LV filling pressure. We investigated whether individuals with OSAS exhibit LV diastolic dysfunction.

Methods: Conventional echocardiography and TDI were performed in 17 patients with OSAS (53.7 ± 10.5 years) and 20 control individuals without OSAS who were matched for age and blood pressure. Longitudinal strain and early strain rate (SR_{dia}) were determined in 8 LV segments. The diagnosis of OSAS was based on polysomnography. The number of apnea/hypopnea episodes per hour (apnea/hypopnea index: AHI), lowest oxygen saturation, sleep stages and the number of arousals per hour (arousal index) were measured.

Results: Strain and SR_{dia} were significantly smaller in OSAS patients than in controls, but the LV ejection fraction did not differ between the two groups. The lowest oxygen saturation was significantly correlated with SR_{dia}. The percentages of sleep stage 1 and arousal index were significantly decreased by successful treatment of OSAS with CPAP. Strain and SR_{dia} were significantly increased in OSAS patients after treatment for 6 months with CPAP.

Conclusion: The repeated episodes of nocturnal oxygen desaturation and sleep fragmentation in individuals with OSAS may result in impairment of LV relaxation.

0466

HUNGER RATINGS CHANGE WITH CIRCADIAN MISALIGNMENT AND SLEEP DEPRIVATION

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Introduction: Increased risk of obesity and other metabolic diseases observed in shiftworkers is thought to be related to consumption of the majority of calories at adverse circadian times. How the circadian system influences appetite at night is largely unknown and was therefore examined in two studies: a simulated shiftwork (SW) protocol with feeding at night and a total sleep deprivation (TSD) protocol with fasting at night.

Methods: Ten healthy adults (4 males) aged 26.3 ± 4.8 y, BMI 22.3 ± 1.7 participated in SW and seven healthy adults (5 males) aged 22 ± 5 y, BMI 22.9 ± 2.4 participated in TSD. Participants maintained ~8 h/night habitual sleep schedules the week prior to study. SW was a 5 day in-laboratory protocol simulating three consecutive nightshifts with Day 2 as baseline, Day 3 as transition to night work, which occurred Nights 3-5. TSD was a 3 day in-laboratory protocol with Day 1 as baseline and Days 2-3 40 h of TSD. Participants were fed meals meeting their daily caloric needs and in both studies, meals were given at approximately 1.5 h, 5.5 h, 10.5 h and 14.5 h awake. Thus, participants were fed at night during SW and fasted at night during TSD. Hunger ratings were assessed every 1-2 h with visual analog scales. Data were analyzed by Mixed Model ANOVA and planned comparisons.

Results: Hunger ratings for sweets, fruits, dairy, meats, and vegetables were lower when food was consumed during the nightshift compared to daytime levels at baseline ($p < 0.05$). Hunger ratings for these foods were also lower when fasting at night during TSD ($p < 0.005$) compared to when feeding during the daytime.

Conclusion: Although shiftworkers are reported to eat the majority of their calories at night, findings from the current study suggest that this pattern is not due to increased hunger at night, rather the circadian clock appears to reduce hunger at night regardless of food intake.

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0467

CIRCADIAN MISALIGNMENT INCREASES CARDIOVASCULAR RISK INDEPENDENTLY OF SLEEP LOSS

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Introduction: Shift work, characterized by irregular schedules resulting in sleep loss and misalignment of circadian rhythms, is associated with increased incidence of cardiovascular disease. We tested whether circadian misalignment has an adverse impact on cardiovascular function independently of sleep loss.

Methods: 19 healthy adults were studied using a parallel group design comparing two interventions. Both interventions involved 3 inpatient days with 10-h bedtimes (B1-B3) followed by 8 inpatient days with 5 hours in bed (D4-D10), either with fixed nocturnal bedtimes (circadian alignment, $n = 8$, 3 women, 24.5 ± 2.7 years old, 23.6 ± 2.5 kg/m²) or with bedtimes delayed by 8.5 hours on 4 of the 8 days (circadian mis-

alignment, $n = 11$, 4 women, 22.5 ± 1.6 years old, 22.1 ± 2.6 kg/m²). Both interventions were followed by 3 nights of recovery sleep, 2 nights with 12-h bedtimes (R12-13) and 1 night with 10-h bedtimes (R14). During each night, heart rate (HR) and cardiac sympathovagal balance (assessed via the ratio of low frequency to high frequency [LF:HF] in the ECG) were estimated over a 5-min period during stable NREM stage 2, slow wave sleep (SWS) and REM sleep. Only 5-min-periods free from artifacts, arousals, leg movements, breathing instability and ectopic beats were analyzed. A generalized linear model for repeated measures was used to examine between-group differences after adjusting for age and BMI.

Results: Total sleep time during the intervention was almost identical in the two groups (4h49min [4 min] vs. 4h46min [6 min]). When compared to the aligned condition, the increase of HR from baseline (B2) was 8 to 10 bpm higher in the misaligned condition during stage 2 ($p:0.0009$), SWS ($p:0.0492$) and REM sleep ($p:0.0083$). LF:HF was higher in the misaligned condition during stage 2 ($p:0.0284$), SWS ($p:0.0450$) and REM sleep ($p:0.0338$).

Conclusion: Circadian misalignment as occurs in shift work may impair autonomic cardiac modulation and increase cardiovascular risk, independently of sleep loss.

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0468

DIFFERENTIAL SLEEP DISTURBANCES IN TWO PHENOTYPES OF SHIFT WORK DISORDER

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Introduction: Most patients meeting diagnostic criteria for Shift Work Disorder (SWD) report insomnia, but only a portion of these insomniacs also report excessive sleepiness. We hypothesize that two phenotypes of SWD, characterized by the presence or absence of excessive sleepiness, experience similar diurnal sleep but different nocturnal sleep.

Methods: 35 night workers completed a sleep diary for two weeks before an overnight phase assessment. Subjects with a history of insomnia or other sleep disorders prior to shift work were excluded. At 17:00, each subject completed an Insomnia Severity Index specific to daytime sleep (ISI-D) and an Epworth Sleepiness Scale (ESS). 12 subjects with normal scores on both scales were classified as controls. 12 subjects with ESS < 10 and ISI-D > 10 were classified “alert insomniacs” (AI). 11 subjects with ISI-D > 10 and ESS > 10 were classified “sleepy insomniacs” (SI). We used t-tests to compare diary-reported sleep parameters between subgroups.

Results: Dim-light melatonin onset was significantly ($p < 0.01$) delayed in controls ($04:54 \pm 3.7$ h) than in both SWD groups: AI ($22:45 \pm 4.9$ h) and SI ($20:55 \pm 4.6$ h). For daytime sleep, both SWD groups reported lower sleep efficiency (82.35% AI; 88.71% SI) and more awakenings (1.62 AI; 1.79 SI) than controls (95.78%; 0.54 awakenings, $p < .05$). The AI group also reported longer daytime latencies than controls (34.59 vs. 13.73 minutes, $p < .05$). At night, however, only the AI group differed from controls ($p < .05$), reporting lower sleep efficiency (81.84% vs. 93.38%), longer latencies (43.97 vs. 17.74 minutes) and more awakenings (1.90 vs. 0.80).

Conclusion: Although both phenotypes of SWD show a nighttime phase and disrupted sleep during the day (a time outside of their circadian sleep phase), the AI phenotype shows sleep disturbances at night that are not seen in controls or the SI group. Since the AI phenotype

presents both nocturnal and diurnal sleep disturbances, its etiology may be traced to factors outside circadian misalignment.

Support (If Any): This study is supported by grant 1K01OH009996-03 from CDC/NIOSH.

0469

UNEXPECTED PHASE DELAYS DURING NIGHT SHIFTS IN A NATURALISTIC PILOT STUDY IN PATROL OFFICERS

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Introduction: It is believed that circadian adaptation to night work does not occur due to inappropriate light during the commute home combined with low light at night. Enriching the workplace with short wavelengths and blocking those in the morning has been proposed as a countermeasure to circadian maladaptation. This study investigated the effect of being exposed to dim blue light at night along with wearing blue-blockers during daytime on the circadian entrainment of patrol officers.

Methods: Phase shift assessment following 4 consecutive night shifts was assessed in 14 patrol officers (aged 25-32 years) submitted to 3 conditions: Blue, Red and Baseline. During Blue and Red conditions, subjects were exposed respectively to 8 uW/cm² of blue and 8 uW/cm² of red (placebo) light in their car during the night shifts and wore blue-blockers after 5 am. Baseline condition did not include any intervention. In each condition, salivary melatonin was collected hourly from 19:00-23:00 the night before and from 21:00-04:00 the night after the four night shifts. Dim-light melatonin onset (DLMO) was calculated using a 5 pg/ml threshold. The study occurred between April and October 2010 at which time sunrise ranged from 04:50-07:00.

Results: Significantly greater phase shifts were experienced in Baseline compared to Blue and Red condition (03:14 ± 01:40 h vs. 01:53 ± 01:27 h and 02:06 ± 01:14 h; $p < 0.05$). Phase shifts ranged from 1.01 to 6.60 h in Baseline, -0.64 to 4.00 h in Blue and -0.56 to 3.76 h in Red condition respectively.

Conclusion: Surprisingly, greater phase-delays were observed in Baseline in which condition natural exposure in the morning should have provoked a phase advance or at best no phase-shift albeit both large and small phase-shifts were observed in each condition. Actigraphic light and activity patterns, as well as phase-angles between sleep, DLMOs and sunrise shall provide information regarding variability and the unexpected phase-delays in Baseline.

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0470

ASSESSMENT OF CLINICAL MEASURES IN NON-24-HOUR DISORDER (NON-24) PATIENTS ENTRAINED BY TASIMELTEON

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Introduction: The majority of totally blind individuals exhibit non-24-hour circadian rhythms due to light signals not reaching the suprachiasmatic nucleus, resulting in Non-24. The central pacemaker controls circadian rhythms of hormone secretion, body temperature, sleep-wake function, and peripheral clocks that control cell cycle, cardiovascular, metabolic, and immune function. HetliozTM (tasimelteon) is a novel cir-

cadian regulator in development for the treatment of Non-24, a serious circadian disorder with no FDA-approved treatment.

Methods: Two phase III double-masked, placebo-controlled studies, SET and RESET, assessed the safety, efficacy and maintenance of effect of tasimelteon (20 mg/day) in blind Non-24 patients. Entrainment of circadian rhythms was assessed from urinary 6-sulfatoxymelatonin at months 1 in SET and month 7 for those continuing in RESET. Clinical assessments included duration and timing of nighttime and daytime sleep, and Clinical Global Impression of Change (CGI-C).

Results: Fourteen patients entrained by month 7 of tasimelteon treatment. Eight entrained at month 1 and six additional entrained by month 7, including 2 with treatment gaps of 32 and 47 days between studies. Tasimelteon-entrained patients experienced 82 more minutes of nighttime sleep and 74 minutes less of daytime sleep in their worst 25% of nights and days respectively (p -values < 0.01) compared to placebo. Entrained patients had 52 minutes improvement in the midpoint of their sleep timing compared to placebo (p -value < 0.01) and an average 1.2 point improvement in CGI-C scores compared to placebo (p -value < 0.01). Entrainment and the corresponding clinical response were lost upon withdrawal of tasimelteon in 80% of patients.

Conclusion: Tasimelteon treatment entrains the circadian pacemaker in blind patients with Non-24. Among Non-24 patients entrained by tasimelteon, we observed significant and clinically meaningful improvements in sleep duration, timing of sleep and global functioning. Continued tasimelteon treatment is necessary to maintain entrainment and the resulting clinical response.

Support (If Any): Vanda Pharmaceuticals Inc. ClinicalTrials.gov (NCT01163032/NCT01430754).

0471

GENETIC SUSCEPTIBILITY AND CIRCADIAN ACTIVITY RHYTHMS IN BLACK MOTHERS OF PRETERM INFANTS: AN EXPLORATORY STUDY

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Introduction: Postpartum depression is prevalent in mothers with a preterm labor. Depressive symptoms are known to be associated with weak circadian activity rhythms (CAR). The short allele of the serotonin transporter gene (5-HTTLPR) has also been shown to be a predictor of depression. This study is aimed to examine if the s allele of 5-HTTLPR is associated with depressive symptoms, and less synchronized CAR during early postpartum among Black mothers with a hospitalized preterm infant.

Methods: Thirty Black mothers completed a set of questionnaires, including the General Sleep Disturbance Scale, Edinburgh Postnatal Depression Scale, and Medical Outcomes Short Form-36. Wrist actigraph was used to collect total sleep time and CAR. Buccal cells from saliva were collected for identifying the short (s/l) or long (l/l) allele of 5-HTTLPR in mothers.

Results: About 38% the mothers were identified as s/l heterozygous and 62% as l/l homozygous. Among the mothers with s/l genotype, 55.5% reported clinically significant depressive symptoms as compared to 38.9% of those with l/l homozygotes. Moreover, mothers with l/l reported significantly greater sleep disturbances as compared to those with s/l. However, mothers with l/l or s/l did not differ significantly in their health-related quality of life, synchronized CAR, or actual nocturnal total sleep time in this sample.

Conclusion: Among the Black mothers with s/l genotype may be more vulnerable to depressive symptoms and poor sleep. The role of serotonin transporter gene in sleep and well-being for Black postpartum women needs to be further explored.

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0472

CIRCADIAN MISALIGNMENT INCREASES 24-H BLOOD PRESSURE

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Introduction: Shift work is a risk factor for hypertension, even after controlling for traditional risk factors such as age, gender and physical activity. We tested the hypothesis that circadian misalignment-typically experienced by shift workers-increases blood pressure (BP).

Methods: Fourteen healthy adults (aged 20-49 years; BMI, 21-29.5 kg/m²; 8 men) each completed two 8-day, in-laboratory protocols, with three baseline days, followed by repeated "days" of either circadian alignment or circadian misalignment (behavioral cycle inverted by 12 h). Throughout both protocols, participants consumed isocaloric meals, remained primarily sedentary during the wake episodes and supine during the sleep episodes. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured approximately every 30 min for 24 h during periods of the alignment/misalignment conditions. Sleep efficiency (SE; the percentage of sleep during each 8-h sleep opportunity) was estimated by wrist-actigraphy during the sleep opportunities in which BP was measured.

Results: Circadian misalignment increased 24-h SBP and DBP by 3 mmHg ($P < 0.0001$) and 2 mmHg ($P < 0.0001$), respectively. These results were primarily explained by an increase in BP during the sleep opportunities (SBP, +6 mmHg, $P < 0.0001$; DBP, +2 mmHg, $P = 0.0003$) and to a lesser extent by raised BP during the wake periods (SBP, +2 mmHg, $P = 0.0004$; DBP, +1 mmHg, $P = 0.0004$). SE significantly explained variance in the SBP ($P = 0.004$), but not DBP ($P = 0.55$) sleep opportunity models. However, even with SE included as a covariate, circadian misalignment still had an independent effect on SBP during the sleep opportunity (+5 mmHg, $P < 0.0001$).

Conclusion: Circadian misalignment per se increases 24-h BP. The effect is largest during sleep, but this seems unrelated to changes in SE. These findings may have implications for shift workers who are more likely to be hypertensive.

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0473

FLASHING BLUE LIGHT EXPOSURE THROUGH CLOSED EYELIDS SUPPRESSES MELATONIN

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Introduction: One hour of continuous exposure to green light (LEDs; lambdamax = 530 nm) delivered by a mask through closed eyelids suppressed melatonin and delayed dim light melatonin onset. Between 17,000 and 75,000 lx (33-131 W/m²) was delivered to the eyelids, depending on eyelid transmittance. Based on a model of human circadian phototransduction, flashing blue lights should be effective for stimulating the human circadian system, thereby significantly reducing the required energy and concomitant heat generated by the LEDs. A within-

subjects study was designed to test whether exposure to 1 h of flashing blue light significantly suppressed melatonin.

Methods: Eleven participants came to the laboratory on two consecutive Friday nights. Counterbalancing across subjects, participants experienced a treatment night where 16,400 lux (111 W/m²) of blue light (LEDs, lambdamax ≈ 480 nm) was flashed on the subjects' eyelids for 2 s, once every 30 s for 1 h via a light-weight mask, and a dark control night for which a non-energized mask was worn. Melatonin concentrations were obtained from blood samples, one collected in darkness (T1) and the other following 1 h of darkness or after exposure to the flashing blue light (T2).

Results: There was a significant main effect of light ($F_{1,10} = 17.6$; $p = 0.002$) and light by time interaction ($F_{1,10} = 14.8$; $p = 0.003$). Melatonin concentrations at T1 were not significantly different between the two experimental nights (mean ± S.E.M = 33 ± 5 and 31 ± 6 pg/ml). At T2, melatonin concentration after exposure to the flashing blue light (30 ± 5 pg/ml) was significantly lower ($p < 0.05$) than after darkness (41 ± 6 pg/ml).

Conclusion: The study contributes to the foundation for clinical treatment of circadian sleep disorders by delivering flashed light through closed eyelids while people are asleep.

Support (If Any): National Institute on Aging (R01AG042602) and Philips Respironics.

0474

ACCURACY FOR AMBULATORY EYE-LEVEL MEASUREMENT OF LIGHT AT NIGHT IN HOME SETTINGS: CROSS-SECTIONAL ASSOCIATION WITH SUBJECTIVE AND ACTIGRAPHIC SLEEP QUALITY IN THE HEIJO-KYO COHORT

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Introduction: Recent advances in the knowledge underlying the association between light at night (LAN) and circadian sleep physiology have enabled developing new devices for accurate measurement of LAN in home settings. In previous epidemiological studies, LAN has been measured using a bedroom light meter facing the ceiling; however, this device may not measure actual exposure of LAN at cornea level that influences human circadian physiology. Therefore, we specially developed an ambulatory eye-level light meter which could measure both intensity and blue light power.

Methods: In this cross-sectional study on 336 elderly individuals (mean age, 70.9 years), we measured LAN exposure using both the ambulatory eye-level light meter and a bedroom light meter facing the ceiling. Subjective and objective sleep quality was measured using the Pittsburgh Sleep Quality Index questionnaire and wrist actigraph, respectively, over two consecutive nights.

Results: The median eye-level intensity and blue light power were 0.89 lux (interquartile range, 0.09 to 3.32) and 2.37×10^{-5} mW/cm² (0.38×10^{-5} to 15.0×10^{-5}). The median bedroom horizontal intensity was 0.71 lux (0.05 to 3.44). Univariate linear regression models showed that eye-level intensity and blue light power were significantly associated with all of the actigraphic sleep quality (sleep efficiency, $R^2 = 0.061$ and 0.046; wake after sleep onset, $R^2 = 0.038$ and 0.018; and sleep onset latency, $R^2 = 0.072$ and 0.073; respectively). These fitness of models were better than those of the associations between bedroom horizontal intensity and actigraphic sleep quality. In addition, univariate logistic regression models analyzing the association between these three LAN exposures and subjective sleep disturbance showed that fitness of model in eye-level blue light power was the best of all of the LAN measures (Nagelkerke $R^2 = 0.037$).

Conclusion: We demonstrated the accuracy for ambulatory eye-level measurement of LAN in home settings.

0475

EXPOSURE TO LIGHT AT NIGHT IN HOME SETTINGS AND RISK OF INSOMNIA IN GENERAL ELDERLY POPULATION: A CROSS-SECTIONAL STUDY IN THE HEIJO-KYO COHORT

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Introduction: Exposure to light at night (LAN) is increasing globally, not only among night-shift workers but also among the general population because of the increased use of artificial lighting in modern society. Under controlled laboratory conditions, LAN suppresses melatonin secretion, delays the internal biological rhythm, and reduces sleepiness. Thus, exposure to LAN may cause circadian misalignment and insomnia, though it remains unclear in real-life situations whether exposure to LAN is associated with insomnia.

Methods: In this cross-sectional study on 857 elderly individuals (mean age, 72.2 years), we evaluated bedroom light intensity and subjectively and objectively measured sleep quality using the Pittsburgh Sleep Quality Index and an actigraph, respectively, along with urinary melatonin excretion. Potential confounders were defined as the variables associated with subjective insomnia ($P < 0.20$).

Results: Compared with the lowest quartile group of LAN intensity, the highest quartile group revealed a significantly higher odds ratio (OR) for subjective insomnia in a multivariate model adjusted for age, gender, body mass index, daytime physical activity, urinary melatonin excretion, bedtime, rising time, and day length (adjusted OR, 1.61, 95% confidence interval, 1.05 to 2.45, $P = 0.029$). In addition, higher OR for subjective insomnia was significantly associated with the increase in quartiles of LAN intensity ($P_{\text{trend}} = 0.043$). Consistently, we observed significant association trends between the increase in quartiles of LAN intensity and poorer actigraphic sleep quality, including decreased sleep efficiency, prolonged sleep-onset latency, increased wake-after-sleep onset, and shortened total sleep time in multivariate models adjusted for the covariates mentioned above (all $P_{\text{trend}} < 0.001$).

Conclusion: We demonstrated that exposure to LAN in home settings is significantly associated with both subjectively and objectively measured sleep quality in a community-based elderly population.

0476

ASSOCIATION BETWEEN CATARACT SURGERY AND QUALITY OF OBJECTIVE SLEEP IN THE ELDERLY: A CROSS-SECTIONAL STUDY OF THE HEIJO-KYO COHORT

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Introduction: The circadian rhythms that regulate sleep-wake cycles in humans are driven by environmental light information processed through the activation of suprachiasmatic nucleus. With increasing age, the crystalline lens becomes cloudy, a condition known as cataract. Cataract decreases light transmission to the retina and may cause circadian misalignment. Previous studies have reported an improvement in the quality of subjective sleep after cataract surgery (CS). However, the relationship between CS and the quality of objective sleep, which is different from the quality of subjective sleep, is not clear.

Methods: In this cross-sectional study on 854 elderly individuals (mean age, 72.1 years), we evaluated the status of CS using a self-reported questionnaire and measured objective sleep quality using an actigraph over two consecutive nights. The quality of objective sleep included three parameters of sleep efficiency (SE), wake after sleep onset (WASO), and sleep onset latency (SOL).

Results: The mean age in the CS group ($n = 129$) was 6.4 years older than that in the no CS group ($n = 725$). The means for SE and WASO were 84.5% (SD, 7.8) and 50.6 min (SD, 29.8), respectively. The median for SOL was 19.5 min (interquartile range, 9.5 to 37.0). Multivariate models adjusted for age, gender, body mass index, sleep medication, and day length revealed that the CS group showed significantly higher SE and shorter WASO than the no CS group (SE, 86.0% vs. 84.2%, $P = 0.025$; WASO 44.6 vs. 51.7 min, $P = 0.017$; respectively). SOL did not significantly differ between the two groups.

Conclusion: Our results showed that CS is associated with better the quality of objective sleep, including higher SE and shorter WASO, in general elderly population. These findings would provide with the hypotheses that CS improves sleep quality, which can be tested in a prospective randomized manner.

0477

PAX6 HAPLOINSUFFICIENCY: PINEAL HYPOPLASIA, REDUCED MELATONIN AND SLEEP DISTURBANCE

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Introduction: PAX6 haploinsufficiency (PAX6 +/-) can occur as part of contiguous gene deletion syndrome (WAGR) or as point mutations and microdeletions affecting only PAX6, which result in isolated aniridia. In addition to its known role in eye development, PAX6 may also play an important role in the development of the pineal, a gland in the brain that produces melatonin, a hormone involved in circadian regulation. We hypothesized that pineal volume, melatonin, and 6-sulfatoxymelatonin (6SM) will be lower and that sleep disturbance would be higher in PAX6 +/- subjects as compared to controls.

Methods: Groups of 40 PAX6 +/- subjects (age 16.3 ± 11.8 y) and 18 controls (15.3 ± 7.5 y) were evaluated during an inpatient admission. Pineal gland appearance was evaluated by brain MRI. Serum melatonin was drawn at 8 AM and midnight (dark room from an IV). Urine was collected at 1st AM void and during the evening. Serum melatonin and 6SM were measured by ELISA. The Child Sleep Habits Questionnaire [CSHQ] was administered for subjects < 12 y. ANCOVAs compared groups (covariates: age, sex, & BMI-Z).

Results: Pineal volume was ~5-fold lower in PAX6 +/- [adjusted mean \pm SEM: 23 ± 5 uL, $p < 0.001$] vs. controls (107 ± 8 uL). Midnight melatonin was lower in PAX6 +/- [33.4 ± 5.6 pg/mL, $p < 0.001$] vs. controls [77.3 ± 7.2 pg/mL]. The 8 AM melatonin values were lower in PAX6 +/- [25.2 ± 3.9 pg/mL, $p = 0.001$] vs. controls [47.2 ± 4.8 pg/mL]. Morning urinary 6SM levels (reflecting nighttime production) were lower in PAX6 +/- [20.6 ± 4.1 ng/mgCr, $p < 0.001$] as compared to controls [47.7 ± 5.2 ng/mgCr]. Evening 6SM levels were similar among groups ($p = 0.17$). CSHQ score was 47.6 ± 1.5 for PAX6 +/- vs. 42.3 ± 2.4 in controls, but was not statistically different ($p = 0.08$).

Conclusion: Pineal volume and melatonin production were lower in PAX6 +/- subjects as compared to controls. In PAX6 +/- children, there was a trend toward greater sleep disturbance. Our findings support the

view that PAX6 plays an important role in pineal development and function.

Support (If Any): This study was supported by the Intramural Research Program of the National Institute of Child Health and Human Development and National Institute of Nursing Research, NIH.

0478

THE SEVERITY OF DEPRESSIVE SYMPTOMS IN RELATION TO CIRCADIAN TIMING OF SLEEP, MELATONIN AND CORTISOL RHYTHMS IN DELAYED PHASE SLEEP DISORDER (DSPD)

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Introduction: Depressive symptoms are commonly reported by those with delayed sleep phase disorder (DSPD), and is thought to be associated with alterations in circadian rhythm function. This study compared the phase angle difference (PAD) between sleep timing and melatonin and cortisol rhythms in DSPD and controls with neither-type, and examined the association of PAD with depressive symptoms.

Methods: Twenty-two patients with DSPD (32.1 ± 10.8 years; M:F = 13:9) and 17 controls (30.7 ± 13.7 years; M:F = 9:8) completed a four or a five-day inpatient study at the Northwestern Clinical Research Center (CRU). Participants with psychiatric diagnoses by a structural clinical interview were excluded. Participants were instructed to maintain a regular but habitual sleep schedule, which was monitored for 1 week using wrist activity monitoring before CRU admission. Plasma samples were collected at 30- to 60-min intervals under dim light conditions (< 10 lux). Dim light melatonin onset 2SD (DLMO) and the second peak of cortisol excretion (CA) were used as circadian phase markers. The severity of depressive symptoms was assessed by Beck Depression Inventory (BDI).

Results: Compared to controls, DSPD patients scored significantly higher on the BDI (9.95 ± 8.05 ; range 1-30 vs 1.65 ± 3.20 ; range 0-12, $p < .01$). DSPD patients were significantly phase delayed in the timing of sleep-wake, DLMO (24.3 ± 1.8 h vs 20.4 ± 1.1 h, $p < .01$) and CA (59.5 ± 3.6 h vs $55.1 \pm .9$ h, $p < .01$), but did not show a significance in PADs between habitual bedtime, DLMO, and CA. BDI scores in total participants were significantly correlated with DLMO and CA ($r = .52$, $r = .53$, $p < .05$), but not with PADs between DLMO and CA.

Conclusion: Even though there was no evidence of internal circadian misalignment between sleep timing, melatonin and cortisol rhythms in DSPD, the degree of the delay in circadian phase reflected the severity of depressive symptoms. This finding supports previous studies indicating that a delayed circadian timing might contribute to increase a risk of depression.

Support (If Any): NHLBI R01HL069988.

0479

CAUSES OF TOTAL BLINDNESS ASSOCIATED WITH NON-24 HOUR DISORDER

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Introduction: Non-24-Hour Disorder (Non-24) is a severe, chronic, circadian rhythm disorder, common in totally blind individuals, characterized by the inability to entrain (synchronize) the master body clock to the 24-hour day. During the development of Hetlioz™ (tasimelteon), a circadian regulator studied for the treatment of Non-24 in the totally blind, we investigated the causes of blindness that lead to Non-24 to better understand the population at risk for this debilitating disorder.

Methods: Causes of blindness were recorded during screening of the SET and 3202 studies. Age of onset for vision loss and for the ability to perceive light were documented for each eye. Non-24 diagnosis was confirmed if patients had both a sleep-wake complaint and a Non-24 circadian rhythm assessed via urinary measurements of 6-sulfatoxymelatonin.

Results: More than 20 ocular conditions were documented among 406 totally blind individuals. Most patients started losing vision from birth and had bilateral no light perception (NLP) by age 16. Retinopathy of prematurity was the most common cause of bilateral NLP for all totally blind individuals screened (25.1%) as for patients with confirmed Non-24 diagnosis (35.1%).

Conclusion: Non-24 can occur at any age and usually coincides with or follows shortly after the total loss of light perception or loss or surgical removal of the eyes. Because patients were selected and screened for inclusion in clinical studies, they may not accurately represent the entire totally blind population. However, results support the hypothesis that the risk of developing Non-24 ultimately depends on the risk of complete loss of circadian photoreceptive function; any condition that abolishes light-dark input to the circadian clock can lead to Non-24. Conditions that damage the ganglion cell layer, affect the optic nerve, or cause removal of eyes are more likely to result in total blindness, and therefore increase the risk of developing Non-24.

Support (If Any): Vanda Pharmaceuticals Inc. (ClinicalTrials.gov NCT00548340, NCT01163032 and NCT01430754).

0480

TASIMELTEON, A NOVEL TREATMENT FOR NON-24 HOUR DISORDER: POOLED SAFETY ANALYSIS OF TWO PHASE II AND TWO PHASE III PLACEBO CONTROLLED STUDIES

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Introduction: Hetlioz™ (tasimelteon) a dual melatonin receptor agonist (DMRA) with selective activity at the MT1 and MT2 receptors in the suprachiasmatic nucleus, is a novel circadian regulator developed for the treatment of Non-24-Hour Disorder (Non-24) in the totally blind, a serious, chronic circadian rhythm disorder for which there is no FDA-approved treatment. Safety assessments were performed during development and, given tasimelteon's centrally acting mechanism, specific assessments of next-day somnolence and the incidence of abnormal dreams and nightmares were also evaluated.

Methods: A pooled analysis of two phase III placebo-controlled studies in blind Non-24 patients and two phase II placebo-controlled studies of sighted patients with insomnia ($n = 429$ tasimelteon, $N = 203$ placebo) assessed the safety of daily 20 mg tasimelteon treatment through collection of clinical adverse events and clinical laboratory results. Additional assessments of the potential for suicidality, abuse, dependence, withdrawal, and endocrine function were also performed.

Results: Serious adverse event rates were similar between treatment groups (1.6% among tasimelteon-treated patients compared to 1.5% among placebo-treated patients), and no serious adverse event was attributed to study drug. Overall, reported adverse events among tasimelteon-treated patients were similar to the rates identified in placebo-treated patients. There was no evidence of increased risk of suicidality, abuse, or withdrawal, and no evidence of endocrine safety signals associated with tasimelteon treatment. Vivid or unusual dreams were observed to occur primarily among tasimelteon-treated patients (2.6% compared to 0.5% in placebo), most frequently early after initiation of treatment, and are considered an expected result of tasimelteon's mechanism of action. Daytime somnolence was reported at an excess rate only among tasimelteon-treated elderly female patients with a diagnosis of primary

insomnia, and was not observed at an excess rate among blind patients with Non-24.

Conclusion: Based upon all of the available safety data, tasimelteon was well-tolerated in studies in blind patients with Non-24, and in studies of patients with primary insomnia.

Support (If Any): Vanda Pharmaceuticals Inc. (ClinicalTrials.gov NCT01163032 and NCT01430754).

0481

ASSESSMENT OF POTENTIAL FOR WITHDRAWAL OR ABUSE WITH THE USE OF THE CIRCADIAN REGULATOR TASIMELTEON

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Introduction: Hetlioz™ (tasimelteon) is a circadian regulator developed for the treatment of Non-24-Hour Disorder (Non-24) in the totally blind. Tasimelteon is a dual melatonin receptor agonist (DMRA), which aims to reset the master body clock in the suprachiasmatic nucleus, resulting in entrainment of the circadian rhythms to align to the 24-hour day-night cycle. Assessment of potential for withdrawal and abuse was conducted in non-clinical and clinical studies.

Methods: The affinity of tasimelteon to receptors of neurotransmitters was evaluated in vitro. A drug-discrimination study and a self-administration study were conducted in rats using as comparator midazolam, a benzodiazepine with known abuse liability. Withdrawal symptoms after abrupt discontinuation of treatment were assessed in three clinical studies (3104, SET, and RESET), using the Tyrer Benzodiazepine Withdrawal Symptom Questionnaire (BWSQ).

Results: Tasimelteon demonstrated selective and potent agonist activity at the MT₁ and MT₂ melatonin receptors without significant interaction with receptors of neurotransmitters associated with abuse potential. No evidence of abuse behaviors was observed in rats in either the drug-discrimination or self-administration studies. Abrupt discontinuation of tasimelteon after 5 weeks of treatment did not appear to cause subjective withdrawal symptoms experienced with benzodiazepines as measured by BWSQ one day after discontinuation (N = 291: 3104 study). No differences were observed between placebo and tasimelteon-treated groups when the BWSQ was administered during the 2-week wash-out following 6 months of treatment (N = 11: SET study) or during the randomized withdrawal phase after 3 months of treatment (N = 20: RESET study).

Conclusion: Non-clinical and clinical study assessments confirmed the expected lack of withdrawal or abuse potential associated with tasimelteon use. These findings are consistent with the pharmacology profile of a circadian regulator with selective agonist activity for both MT₁ and MT₂ receptors, and are supportive of the safety profile of tasimelteon.

Support (If Any): Vanda Pharmaceuticals Inc. (ClinicalTrials.gov NCT00548340, NCT01163032 and NCT01430754).

0482

LQ-NTST, UQ-DTSD AND MOST: CIRCADIAN SPECIFIC SLEEP/WAKE MEASURES FOR NON-24 PATIENTS

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Introduction: The majority of totally blind individuals exhibit non-24-hour circadian rhythms due to light signals not reaching the suprachiasmatic nucleus (SCN), resulting in Non-24-Hour Disorder (Non-24).

Patients experience periodic disruptions of their sleep-wake cycle as a result of the inability to entrain their circadian rhythms to a 24-hour day. Non-24 is a disorder of the timing of sleep with patients suffering from reduced nighttime total sleep time (nTST) and increased daytime total sleep duration (dTSD) when out-of-phase. Hetlioz™ (tasimelteon) is a novel circadian regulator in development for Non-24, a serious circadian rhythm disorder with no FDA-approved treatment.

Methods: SET, a six-month phase III, placebo-controlled study demonstrated the Safety and Efficacy of Tasimelteon treatment (20 mg/day) in blind patients with Non-24. The worst 25% of nights of nTST (LQ-nTST), the worst 25% of days of dTSD (UQ-dTSD) and the midpoint of sleep timing (MoST) were assessed between the entrained individuals and Non-24 patients during the screening phase. An exploratory analysis was conducted via an Analysis of Variance Model to compare the differences between populations. Additionally, the correlation between clinical endpoints and circadian phase during the screening phase was explored for all randomized patients.

Results: All clinical endpoints show significant differences between entrained individuals (n = 51) and Non-24 patients (n = 121). Non-24 patients experienced 68 minutes less LQ-nTST (p < 0.0001) and 64 minutes more UQ-dTSD (p < 0.0001) compared to entrained individuals. Non-24 patients had a reduced/worse MoST (43 minutes; p < 0.0001) compared to entrained subjects. Screening data of the randomized patients showed that these clinical endpoints are highly correlated with circadian phase.

Conclusion: The clinical endpoints of LQ-nTST, UQ-dTSD and MoST are highly specific to Non-24. Furthermore, these measures are highly correlated with circadian phase. These measures are specific and meaningful clinical endpoints for the study of potential treatments of Non-24.

Support (If Any): Vanda Pharmaceuticals Inc. (ClinicalTrials.gov NCT01163032/NCT01430754).

0483

PHASE ANALYSIS OF NIGHTTIME TOTAL SLEEP TIME (NTST) AND DAYTIME TOTAL SLEEP DURATION (DTSD) IN PATIENTS WITH NON-24-HOUR DISORDER

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Introduction: The majority of totally blind individuals exhibit non-24-hour circadian rhythms due to light signals not reaching the suprachiasmatic nucleus (SCN), resulting in Non-24-Hour Disorder (Non-24). As a result of the inability to entrain their circadian rhythms to a 24-hour day patients, suffer from reduced nighttime total sleep time (nTST) and increased daytime total sleep duration (dTSD) when they cycle out-of-phase with the 24-hour day. Hetlioz™ (tasimelteon) is a novel circadian regulator in development for Non-24, a serious circadian rhythm disorder with no FDA-approved treatment.

Methods: SET, a six-month phase III, placebo-controlled study demonstrated the Safety and Efficacy of Tasimelteon treatment (20 mg/day) in blind patients with Non-24. An exploratory analysis of the mean difference in nTST and dTSD when patients were in-phase compared to out-of-phase was conducted. Circadian phase was extrapolated from pre-treatment aMT6s data. Circadian phase was extrapolated from pre-treatment aMT6s data. The absolute value difference was used to measure the magnitude of change across the circadian cycle. Treatment difference was evaluated with an ANOVA.

Results: The in-phase/out-of-phase difference of nTST and dTSD between tasimelteon and placebo was statistically different (p < 0.05). The greater variability observed in the placebo arm is consistent with the cyclic disorder.

Conclusion: The SET study demonstrated that tasimelteon treatment entrains the circadian pacemaker in blind patients with Non-24. Entrained patients no longer cycled in- and out-of-phase; consequently their sleep-wake schedule was stabilized. This exploratory analysis suggests that tasimelteon decreased the cyclical variability of both nighttime and daytime sleep in patients with Non-24.

Support (If Any): Vanda Pharmaceuticals Inc. (ClinicalTrials.gov NCT01163032).

0484

CORTISOL AND DIM LIGHT MELATONIN ONSET TIMING IN ADOLESCENTS WITH AUTISM SPECTRUM DISORDER

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Introduction: Individuals with autism spectrum disorder (ASD) display high levels of anxiety and stress, exhibit a high prevalence of sleep disorders, and show disturbances in the HPA axis. Alterations in the timing of melatonin synthesis and/or melatonin metabolism have been suggested in ASD suggesting a possible circadian contribution. We hypothesized an association between cortisol and the dim light melatonin onset (DLMO).

Methods: Saliva samples were collected at home in dim light every 30 minutes from 6:30 pm until natural bedtime for up to 5 nights (Thursday-Sunday) and assayed for melatonin from 9 adolescents with ASD ages 13-20 years. Cortisol samples were obtained from salivary samples collected immediately prior to bedtime and upon waking on Friday and Saturday. Participants wore an actigraph, to measure daytime and nighttime activity for 28 days. Cortisol samples were averaged for each individual. Associations were examined using Spearman correlations.

Results: Later DLMO was associated with higher evening cortisol levels ($r_s = 0.7$, $p = 0.05$) and marginally associated with higher morning cortisol levels ($r_s = 0.6$, $p = 0.07$). Sleep fragmentation was associated with higher evening cortisol ($r_s = 0.8$, $p = 0.01$) and higher evening-morning cortisol ratio ($r_s = 0.7$, $p = 0.03$).

Conclusion: The association of higher evening cortisol levels with later DLMOs suggests a possible HPA axis dysfunction in adolescents with ASD, as well as an aspect of circadian timing. Individuals with more daytime stressors may exhibit a diminished reduction in the fall of cortisol in the evening associated with insomnia. This finding will be expanded in additional work.

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0485

THE PREVALENCE AND IMPACT OF SLEEP DISORDERS IN COLLEGE STUDENTS

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Introduction: Sleep complaints among college students have been found to be prevalent and are associated with a variety of negative outcomes. However, previous research in this population has relied on

self-report questionnaires to determine the prevalence of sleep disorders. The purpose of this study was to use a brief clinical interview to more accurately determine the diagnostic prevalence and associated outcomes of sleep disorders in this population.

Methods: College students ($n = 277$) were recruited from a university research subject pool and completed a battery of eight self-report questionnaires assessing sleep, physical/mental health, and academic performance. Students ($n = 153$) who reported sleep complaints then completed a 15-20 minute clinical interview over the telephone to determine clinical diagnoses based on ICSD-2 diagnostic criteria.

Results: In this sample, 74.6% of students indicated some type of frequent and severe sleep complaint by self-report questionnaire. However, only 27.8% of the sample met diagnostic criteria for a sleep disorder. Delayed Sleep Phase Disorder (12.3%) and Behaviorally Induced Insufficient Sleep Syndrome (8.3%) were the two most prevalent sleep disorders, followed by insomnia (5.1%), RLS (1%), and idiopathic hypersomnolence (1%). Students with a sleep disorder reported more mental and physical health complaints ($p < .001$), missed more class due to illness ($p < .01$), but did not report a lower GPA ($p = ns$).

Conclusion: These results suggest that sleep complaints are prevalent among college students. The overall prevalence of sleep disorders is comparable to what has been found in adults, yet the prevalence of specific diagnoses differs. Additionally, the presence of a sleep disorder is associated with negative outcomes. Longitudinal analyses may be helpful in further examining outcomes associated with sleep complaints. These findings suggest that sleep complaints should be evaluated in this population and underscore the importance of a clinical interview in the diagnostic process.

Support (If Any): UA Department of Psychology.

0486

OCCUPATIONAL AND NEUROPHYSIOLOGICAL DEFICITS IN SHIFT WORK DISORDER RELATE TO INSOMNIA, NOT SLEEPINESS

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Introduction: We examine whether insomnia and excessive sleepiness, the two diagnostic symptoms of Shift Work Disorder (SWD), are differently related to evoked responses and work impairment.

Methods: 34 night workers participated in an overnight MSLT and evoked potential assessment. Subjects had no sleep disorders prior to starting night work. At 17:00, each subject completed an Endicott Work Productivity Scale (EWPS), two Insomnia Severity Indices (ISI-Day, ISI-Night), and an Epworth Sleepiness Scale (ESS). Subjects with ISI-Day ≥ 10 and ESS < 10 were classified "alert insomniacs" (AI, $n = 12$). Subjects with ISI-Day ≥ 10 and ESS ≥ 10 were classified "sleepy insomniacs" (SI, $n = 11$). Subjects reporting < 10 on both scales were classified controls ($n = 11$). At 18:00, subjects completed a test of attention to novelty and associated ERPs.

Results: Neither the MSLT nor the ESS correlated with EWPS scores or ERP amplitudes ($p > .10$). However, the mean of the ISI measures correlated with the EWPS ($r = .409$, $p < .01$) and the attention-to-novelty P3a ($r = -.410$, $p < .01$). The AI group was most impaired on the EWPS, significantly more impaired than controls (25.8 ± 14.8 vs. 12.3 ± 9.4 , $p < .05$). SI were not statistically different from controls (19.5 ± 8.7 vs. 12.3 ± 9.4 , $p > .05$). Interestingly, the fatigue subscale of the EWPS was significantly higher in AI than in controls (6.3 ± 3.1 vs. 3.4 ± 2.5 , $p < .05$), while there was no significant difference between SI and controls (4.8 ± 1.7 vs. 3.4 ± 3.1 , $p > .10$). Compared to controls, AI showed significantly attenuated P3a responses (FcZ, CzP, CpZ, MD 1.62-1.77, $p < .05$) and target-detection P3b responses (FcZ, CzP, CpZ, MD 1.28-1.64, $p < .05$).

P3b in SI was not different from controls ($p > .10$) and P3a was only different at one electrode (Cpz, MD 1.43, $p < .01$).

Conclusion: Insomnia is linked to functional and cognitive impairments in shift workers. Insomniacs with normal sleepiness showed more severe impairments than insomniacs who reported excessive sleepiness.

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0487

ATTENTIONAL BRAIN RESPONSES IN NIGHT SHIFT WORKERS ARE SENSITIVE TO OCCUPATIONAL IMPAIRMENT

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Introduction: The Endicott Work Productivity Scale (EWPS) is a self-report assessment of occupational functioning. We correlated global and subscale EWPS scores to evoked response potentials (ERPs), objective measures of cognitive function, in a sample of shift workers.

Methods: 34 night workers participated in an overnight neurophysiology (e.g., ERP) assessment. Subjects with a history of insomnia or other sleep disorders prior to shift work were excluded. At 17:00, each subject completed an Endicott Work Productivity Scale (EWPS). At 18:00, each participant performed an “active” attention ERP task. Mean electrical amplitudes corresponding to attentional orienting (P3a) and target detection (P3b) were calculated and compared across all participants.

Results: Total EWPS scores were correlated with the P3a, an attention-to-novelty response (Cpz, $r = -.344$, $p < .05$). The fatigue subscale (items such as losing interest, becoming reckless, and falling asleep at work) was correlated to the P3a response (Cpz, $r = -.523$; Pz, $r = -.511$, $p < .01$), as was the executive function subscale (difficulty concentrating, organizing work, and forgetting information; Czp, $r = -.343$, $p < .05$). Three subscales measuring interpersonal interactions, work efficiency, and counterproductive work behavior did not significantly relate to ERP amplitudes. None of the EWPS scores related to P3b (target detection) amplitudes.

Conclusion: ERP measures of attentional orienting were related to several components of self-reported occupational performance in a sample of night shift workers. Specifically, the P3a, a measure of frontal attention orienting, was highly sensitive to scale items assessing executive function. We found no evidence for a relationship between work functions and the parietal P3b response associated with target detection and memory update processes, supporting the notion that impairments seen in Shift Work Disorder are largely distributed over the frontal lobe.

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0488

A RANDOMIZED CONTROLLED TRIAL OF MINDFULNESS MEDITATION FOR CHRONIC INSOMNIA: LONG-TERM OUTCOMES*Ong JC¹, Manber R², Segal Z³, Xia Y⁴, Shapiro S⁵, Wyatt J¹*¹Rush University Medical Center, Chicago, IL, USA, ²Stanford University, Stanford, CA, USA, ³University of Toronto, Toronto, ON, Canada, ⁴University of Rochester, Rochester, NY, USA, ⁵Santa Clara University, Santa Clara, CA, USA

Introduction: This study examined the efficacy of two mindfulness-based interventions compared to a self-monitoring control (SMC). Mindfulness-Based Stress Reduction (MBSR) is a standard 8-week group intervention that teaches mindfulness meditation as a general practice for emotion regulation with no specific recommendations for sleep. Mindfulness-Based Therapy for Insomnia (MBTI) is a novel 8-week group intervention that integrates mindfulness meditation practice with sleep restriction, stimulus control, and sleep hygiene.

Methods: Fifty-four participants (74% female, mean age = 43 years) with chronic psychophysiological insomnia (> 6 months) were randomized to receive MBSR (n = 19), MBTI (n = 19), or an 8-week SMC (n = 16) condition using sleep diaries. Patient-reported outcome measures were total wake time (TWT) derived from sleep diaries and the pre-sleep arousal scale (PSAS), measuring a prominent waking correlate of insomnia. Objective measures of sleep included laboratory polysomnography and wrist actigraphy. Clinical endpoints were remission and response defined by validated criteria on the Insomnia Severity Index (ISI).

Results: Linear mixed models showed significantly greater reduction on TWT and PSAS scores in the combined study arms that received meditation treatment (MBTI and MBSR) compared to SMC from baseline-to-post and from baseline-to-six-month follow-up. For the meditation arms, the mean reduction in TWT from baseline was 43.75 minutes at post-treatment and 49.63 minutes at 6-month follow-up, showing treatment durability. Remission and response rates in MBTI and MBSR were sustained throughout follow-up, with MBTI showing the highest rates of treatment response (78.6%) at the 6-month follow-up. No significant differences were found between MBSR and MBTI.

Conclusion: These findings indicate that mindfulness meditation alone (MBSR) or in combination with behavior therapy (MBTI) are viable treatment options for adults with chronic insomnia with durability through 6-months post-treatment. Mindfulness-based treatments could provide an alternative to traditional treatments for insomnia.

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0489

DURABILITY OF TREATMENT RESPONSE TO ZOLPIDEM WITH THREE DIFFERENT MAINTENANCE REGIMENS: NIGHTLY, INTERMITTENT, AND PARTIAL REINFORCEMENT DOSING*Perlis ML^{1,2}, Zee J³, Bremer E¹, Whinnery J¹, Barilla H¹, Andalia PA¹, Gehrman PR^{1,2,4}, Morales KH³, Grandner MA^{1,2}, Ader R⁵*¹Behavioral Sleep Medicine Program, Department of Psychiatry, University of Pennsylvania, Philadelphia, PA, USA, ²Center for Sleep and Circadian Neurobiology, University of Pennsylvania, Philadelphia, PA, USA, ³Department of Biostatistics and Epidemiology, University of Pennsylvania, Philadelphia, PA, USA, ⁴Philadelphia Veterans Affairs Medical Center, Philadelphia, PA, USA, ⁵Department of Psychiatry, University of Rochester, Rochester, NY, USA

Introduction: At present there is no consensus regarding how to medically manage insomnia long term. While hypnotics have been shown to be effective when used on a nightly basis for up to 12 months, it is generally held that these effects cannot be maintained ad infinitum and that once medical treatment is discontinued, most (if not all) clinical gains are lost. This being the case, the unstated standard of practice is for patients to use hypnotics intermittently. In the present study, nightly and intermittent dosing strategies with 10 mg zolpidem (QHS and IDS, respectively) were compared to a Partial Reinforcement Strategy (PRS [nightly pill use with 50% active meds and 50% placebos]).

Methods: 56 subjects were treated with 10 mg zolpidem for one month. Treatment responders were randomized to one of the three maintenance regimens for three months. All subjects completed a daily online sleep/pill-use diary and a weekly side effect survey. Medication was disbursed and collected on a monthly basis (foil packs). All subjects were assessed for their clinical status on a bi-weekly basis (continued response or relapse).

Results: For the present analysis, data are reported for only the subjects that adhered to the medication regimens (QHS = 81% [n = 13/16], PRS = 65% [n = 13/20], and IDS = 75% [n = 15/20], p = 0.35). In brief, the three groups were not different for relapse rates, latency to relapse, or for their sleep continuity profiles. The only effect evident was that PRS was associated with fewer days with side effects.

Conclusion: The present findings suggest that any of the three strategies evaluated may be used to maintain treatment response over time. The critical question for future research is whether the PRS approach (as compared the intermittent dosing strategy) can be effective at substantially lower rates of medication use (e.g., nightly pill use with 0%, 14%, or 28% active meds).

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0490

COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA REDUCES NIGHT TO NIGHT VARIABILITY OF INSOMNIA SYMPTOMS*Dawson SC¹, Pilon AJ¹, Cousins J², Sidani S³, Epstein D⁴, Moritz P⁵, Bootzin RR¹*¹Psychology, University of Arizona, Tucson, AZ, USA, ²University of Pittsburgh, Pittsburgh, PA, USA, ³Ryerson University, Toronto, ON, Canada, ⁴Phoenix Veterans Affairs Health Care System, Phoenix, AZ, USA, ⁵University of Colorado Health Services Center, Denver, CO, USA

Introduction: Night-to-night sleep variability in insomnia is associated with lower self-rated sleep quality and higher levels of depressive symptoms. Previous research has shown that sleep variability decreases following cognitive behavioral therapy for insomnia (CBTI), though CBTI has not been compared to other interventions in this regard. The present study compared CBTI to sleep education and hygiene (SEH), investigating the effects on sleep variability.

Methods: The present study used all available data from one of four sites of a multisite study of research methods in insomnia treatment trials, including 41 participants who received CBTI and 46 who received SEH. Participants completed two weeks of sleep diaries at pre-treatment, post-treatment, and three month follow-up. Night-to night sleep variability was operationalized as an insomnia composite score (ICS): the sum of the root mean square of successive differences in minutes of sleep onset latency, wake after sleep onset, and total sleep time. Multilevel modeling was used to test the effects of treatment on ICS.

Results: CBTI was superior to SEH in reducing ICS, $F(2, 157) = 3.24$, $p < 0.05$. There was no significant pre-treatment difference in ICS between groups, $p = 0.99$. In the CBTI group, ICS decreased from 78.51 to 51.83 following treatment, $p < 0.0001$, and remained relatively unchanged at 51.99 at follow-up, $p = 0.99$. In the SEH group, ICS decreased from 80.36 to 63.03 following treatment, a difference that was marginally significant, $p < 0.06$. ICS then increased in the SEH group during follow-up to 74.34, though this was not statistically significant, $p = 0.48$.

Conclusion: This is the first study to our knowledge demonstrating the efficacy of CBTI in reducing night-to-night variability of insomnia symptoms in the context of a randomized controlled trial. Those who received CBTI showed large reductions in night-to-night sleep variability, which remained stable at three months post-treatment.

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0491

CAN WE CIRCUMVENT THE TRANSITION FROM ACUTE TO CHRONIC INSOMNIA WITH A 'SINGLE-SHOT' CBT-I?

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Introduction: Despite considerable evidence that Cognitive Behavioural Therapy for Insomnia (CBT-I) is effective and efficacious for chronic insomnia, it has yet to be examined within a preventative context. The aim of the present study was to examine whether a single session of CBT-I, with an accompanying information leaflet, would circumvent the transition from acute to chronic insomnia.

Methods: 20 individuals (9 males and 11 females, mean age 32.9 ± 14.02) with acute insomnia completed the Insomnia Severity Index (ISI) prior to, on completion, and a month following the single session intervention (delivered individually). Further, sleep diaries were completed over the entire intervention period. Changes between baseline and follow up were compared between those in the intervention group and an age and sex matched control group of individuals with acute insomnia ($n = 20$).

Results: There were no between group differences on baseline ISI scores ($t(38) = .78$, $p = .44$). However, there was a significant between-group difference on ISI scores at the one-month follow up ($t(38) = 2.24$, $p < .05$), with significantly lower scores being reported by the intervention group ($M = 9.6 \pm 4.99$) compared to the control group ($M = 12.65 \pm 3.51$). Further, following the intervention 60% of those in the intervention group had remitted compared to 15% of those in the control group. Interestingly, the severity of the initial complaint was unrelated to treatment success, as measured by changes in ISI scores ($r = .01$, $n = 20$, $p = .98$).

Conclusion: The findings suggest that a single session CBT-I intervention has a significant impact, above and beyond that typically observed during the natural evolution of insomnia, on the transition to chronic insomnia. The results provide a compelling 'first indication' for a preventative agenda in the management of insomnia in primary care and are discussed in terms of their integration into routine care.

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0492

EFFECTS OF GENDER ON ZOLPIDEM EFFICACY AND SAFETY

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Introduction: Gender-related PK differences in zolpidem have been reported. In June 2013 the FDA issued an advisory for reducing zolpidem doses in women (5 mg). Few studies have assessed gender-related PD differences. In a post hoc analysis of data assessing 12 months of nightly 10 mg zolpidem efficacy and safety in insomnia, we evaluated gender effects.

Methods: Insomniacs ($N = 89$) meeting DSM-IV-TR criteria and NPSG sleep efficiency of $\leq 85\%$, ages 23-70 yrs, without psychiatric disease or drug dependency were randomly assigned to receive 10 mg zolpidem or placebo, double-blind, nightly for 12 months. In months 1 & 8, efficacy and safety was assessed with a 8 hr NPSG and MSLT. Also dose escalation and rebound insomnia were assessed at months 1, 4, and 12. The 3 efficacy measures (SE, LPS, WASO) and 3 safety measures (MSLT for residual effects, # capsules self-administered (SA) for dose escalation, $SE < \text{screening SE}$ for rebound) were analyzed by gender [male ($n = 33$), female ($n = 56$)] and zolpidem ($n = 47$) versus placebo ($n = 42$).

Results: Zolpidem increased SE ($p = 0.001$) and reduced LPS ($p = 0.001$) and WASO ($p = 0.002$) in months 1 and 8 with no gender \times drug interactions. No main effects of zolpidem or gender on MSLT were found. In months 8 and 12 there was a gender by zolpidem interaction ($p = 0.05$), with zolpidem reducing MSLT in men, but not in women. More zolpidem was SA than placebo ($p = 0.04$), but there was no dose escalation and no gender differences in SA. Zolpidem discontinuation did not induce rebound insomnia and there were no gender differences in rebound.

Conclusion: Gender-related PK differences do not translate into gender-related zolpidem efficacy and safety differences.

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0493

COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA IN OLDER VETERANS: FINAL RESULTS OF A RANDOMIZED TRIAL

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Introduction: Prior research has demonstrated the effectiveness of cognitive behavioral therapy for insomnia (CBTI) in older adults. Unfortunately, availability of behavioral sleep medicine (BSM) specialists to provide CBTI is limited in some areas. We recently completed a randomized controlled trial testing CBTI provided by health educators (with telephone supervision by BSM specialists) for older adults with chronic insomnia. We previously reported improvements in sleep between baseline and post-treatment assessments. Here we report final 6- and 12-month effects on sleep and other outcomes.

Methods: We randomized 159 older veterans (97% male, mean age 72.2 years, 79% non-Hispanic white) who met ICSD-2 diagnostic criteria for insomnia of > 3 months duration to one of 3 groups: 1) individual CBTI (iCBTI), 2) group CBTI (gCBTI), or 3) attention control. Active treatment combined sleep restriction, stimulus control and cognitive therapy; and was provided by health educators with weekly telephone supervision by a BSM specialist. Controls received general sleep education. All 3 conditions involved 5 sessions over 6 weeks. Outcome measures were collected at baseline, post-treatment, 6-month (i.e., the

primary endpoint) and 12-month follow-up. A priori primary outcome measures included 7-day sleep diary (sleep onset latency [SOL-d], wake after sleep onset [WASO-d], and sleep efficiency (SE-d)), 7-day actigraphy (sleep efficiency, SE-a), Pittsburgh Sleep Quality Index (PSQI), depressive symptoms (Patient Health Questionnaire-9), and health-related quality of life (Short Form-12). Analyses were intent-to-treat, ANCOVA, adjusted for baseline values.

Results: At 6 months follow-up, compared to controls, participants randomized to either active intervention had shorter SOL-d (iCBTI 19.3 minutes, $p = .002$; gCBTI 22.5 minutes, $p = .017$; controls 32.8 minutes) and greater SE-d (iCBTI 85.5%, $p < .001$; gCBTI 84.3%, $p = .005$; controls 78.6%). PSQI scores also improved (iCBTI 5.8, $p = .005$; gCBTI 5.6, $p = .002$; controls 7.7). WASO-d and SE-a did not differ between groups. Significant sleep improvements at 6-months were maintained at 12 months follow-up (all $p < .05$). Depressive symptoms and health-related quality of life were not different between groups at 6- or 12-months follow-up.

Conclusion: CBT-I provided individually or in a group by health educators with telephone supervision by BSM specialists improves sleep in older adults with chronic insomnia. Improvements in depression and health-related quality of life were not seen. CBT-I provided by health educators may be effective in improving sleep among older adults with chronic insomnia.

Support (If Any): VA Health Services Research and Development; Geriatric Research, Education and Clinical Center at VA Greater Los Angeles.

0494

IMPACT OF THE WEB-BASED COGNITIVE BEHAVIORAL THERAPY PROGRAM ON INSOMNIA SYMPTOMS AND PERCEIVED STRESS: RESULTS OF A RANDOMIZED CONTROLLED TRIAL

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Introduction: Although 10-20% of adults suffer from insomnia, behavioral treatments are infrequently sought due to costs, absence of trained clinicians, and inaccessibility. We postulate that an innovative 6-week, web-based sleep program based on CBT-I principles, “Go!@To Sleep” (GoTS), effectively treats patient’s insomnia symptoms and perceived stress.

Methods: Consenting chronic insomnia participants with internet access were recruited by outreach efforts (Cleveland Clinic newsletters, Wellness Institute email “tips”, and flyers). Primary insomnia participants were randomized to GoTS or Wait-list control groups. Inclusions included sleep onset latency and/or wakefulness after sleep onset ≥ 30 minutes for ≥ 3 times a week, self-reported insomnia problem ≥ 6 months, and significant daytime sleep-related impairment. Exclusions included self-reported psychiatric, medical and other sleep disorders, or use of over-the-counter or prescribed medication for sleep ≥ 3 x/week. Excluded comorbid participants were eligible for a observational side-study on the GoTS program. Pittsburgh Insomnia Rating Scale (PIRS), Insomnia Severity Index (ISI), and Perceived Stress Scale (PSS) scores were obtained at baseline and 6 weeks. Mixed effects models comparing interactions between groups allowed treatment effect comparisons.

Results: Thirty of $n = 51$ (age 54 ± 12.0 , 90% female) GoTS participants provided follow up data, and forty of $n = 50$ Wait-Listers (age 54.6 ± 12.6 , 80% female) doing likewise. No baseline group differences were present. At 6-week follow up, score group-level reductions were noted for PIRS (-13.18; $p < 0.001$; SE = 2.21), ISI (-5.95; $p < 0.001$;

SE = 1.15), and PSS (-5.84; $p < 0.001$; SE = 1.51). Improvements were also seen among the comorbid participants ($n = 152$) PIRS (-13.98; $p < 0.001$; SE = 0.82), ISI (-7.04; $p < 0.001$; SE = 0.30), and PSS (-5.40; $p < 0.001$; SE = 0.48).

Conclusion: The randomized controlled trial confirmed previously published literature by showing that web-based CBT-I in primary insomnia is effective in improving sleep quality and insomnia symptoms. More novel was the demonstrated improvement in perceived stress, a potentially separate pathway toward symptom reduction. These findings raise confidence that GoTS works effectively for comorbid insomnia, addressing some barriers to behavioral care for insomnia.

0495

A RANDOMIZED, PARTIALLY BLINDED, NON-INFERIORITY TRIAL OF MINDFULNESS-BASED STRESS REDUCTION COMPARED TO COGNITIVE-BEHAVIORAL THERAPY FOR THE TREATMENT OF INSOMNIA IN CANCER SURVIVORS

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Introduction: Insomnia is a prevalent and persistent disorder that frequently co-occurs with psychological distress in cancer patients. Our study examined whether Mindfulness-Based Stress Reduction (MBSR) is non inferior to Cognitive Behavioral Therapy (CBT-I) for the treatment of insomnia in cancer patients.

Methods: The I-CAN SLEEP trial was a randomized, partially blinded, non inferiority trial involving cancer patients with insomnia recruited from a tertiary cancer center in Calgary, Alberta from September 2008-March 2011. Assessments were conducted at baseline, post-program and three month follow up. The non inferiority margin was 4 points measured by the Insomnia Severity Index. Sleep diaries and actigraphy measured sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST) and sleep efficiency. Secondary outcomes included sleep quality, sleep beliefs, mood and stress.

Results: Of 327 patients screened, 111 were randomized (CBT-I = 47; MBSR = 64). MBSR was inferior to CBT-I for improving insomnia severity immediately post-program ($p = .35$) but MBSR demonstrated non inferiority at follow up ($p = .02$). Sleep diary measured SOL was reduced by 22 min in CBT-I and 14 min in MBSR at follow up. Similar reductions in WASO were observed for both groups. TST increased by 0.60 hrs for CBT-I and 0.75 hrs for MBSR. CBT-I improved sleep quality ($p < .001$) and dysfunctional sleep beliefs ($p < .001$) while both groups reduced stress ($p < .001$) and mood disturbance ($p < .001$).

Conclusion: While MBSR produced clinically significant change in sleep and psychological outcomes, CBT-I was associated with rapid and durable improvement and remains the best choice for the non-pharmacological treatment of insomnia. For some, MBSR may be a reasonable alternative for the management of insomnia.

Support (If Any): The Canadian Cancer Society Research Institute, the Alberta Cancer Board and a Francisco J. Varela award from the Mind & Life Institute.

0496

COGNITIVE BEHAVIORAL INSOMNIA THERAPY LEADS TO PAIN REDUCTIONS THROUGH IMPROVING THE SLEEP OF FIBROMYALGIA PATIENTS

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Introduction: Studies evaluating cognitive-behavioral insomnia therapy (CBT) among patients with comorbid pain and insomnia show that CBT improves sleep, but it is less clear whether it leads to pain reductions. This study tested whether CBT for insomnia exerts an enduring positive effect on pain through an improvement of insomnia in a sample of patients with fibromyalgia (FM).

Methods: Sixty-one individuals (59 women; ages 24-65) meeting research diagnostic criteria for insomnia and for FM were randomized to: treatment as usual (TAU; n = 21), TAU + sham therapy (ST; n = 20), or TAU + CBT (n = 20). The primary sleep outcome was the Insomnia Severity Index (ISI) score at post-treatment (POST). To evaluate pain, we used the Manual Tender Point Survey, a method assessing pain sensitivity by pressure in 18 tender points (rated on a 0-10 scale/each), and the Brief Pain Inventory (BPI), a questionnaire providing 2 scores indicating pain intensity and its interference with daily functions. We conducted mediation models and the Sobel test using a nonparametric bootstrapping procedure to ascertain whether there is an indirect effect of CBT via insomnia improvement on pain outcomes at POST and 6-month follow-up (FU) assessments.

Results: Compared to TAU, individuals receiving CBT showed statistically significant lower ISI scores at POST (p = .006). The Sobel test indicated that there was a beneficial and statistically significant indirect effect of CBT on the 3 pain outcomes at POST occurring through insomnia improvement (pain sensitivity: point estimate = -15.99, 95% bootstrap confidence interval (CI) = -33.57/-1.67; pain intensity = -1.27, 95% CI = -2.47/-0.32; and pain interference = -1.41, 95% CI = -2.68/-0.37). The indirect effects of CBT on these measures at FU were also statistically significant. Although the ST group showed lower scores on the ISI at POST than did the TAU group (p = .03), there was not a statistically significant indirect effect of ST on pain sensitivity at POST or at FU. Although we found a statistically significant indirect effect of ST on the BPI scores at POST via insomnia improvement (pain intensity = -0.76, 95% CI = -1.63/-0.09; pain interference = -1.11, 95% CI = -2.26/-0.10), these effects were not present at FU.

Conclusion: Our results indicate that CBT improves insomnia which, in turn, improves pain among FM patients. These beneficial effects of CBT on different measures of pain persist long term, well beyond treatment termination. This supports the notion that disturbed sleep is related to pain and underscores the usefulness of CBT for the overall management of FM.

Support (If Any): National Institute of Arthritis, Musculoskeletal and Skin Diseases, Grant # R01AR052368.

0497

PERSISTENT INSOMNIA AND ALL-CAUSE MORTALITY IN A COMMUNITY-BASED COHORT

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Introduction: Insomnia is a common medical complaint and may be associated with increased risk of death. Only half of such individuals suffer from persistent (chronic) insomnia. We set out to determine whether insomnia that was persistent over 8 years was associated with all-cause mortality independent of the effects of confounding factors in a population that was representative of the general adult community.

Methods: Prospective longitudinal study of 1409 adult participants of the Tucson Epidemiological Study of Airway Obstructive Disease (TESAOD) with insomnia determination by questionnaire in 1984-85 and again in 1990-92. Complete review of vital status as of January 1st, 2011. Participants were derived from a multistage, stratified cluster sample of non-Hispanic white households to constitute a community-based population. Persistent symptoms of trouble falling asleep, staying asleep, or waking up too early in the morning accompanied by at least one symptom of impaired daytime function. Confounders such as age, sex, body mass index, smoking status, pack-years, regular physical activity, and use of alcohol or medications to get to sleep. Additional confounders that were tested in sensitivity models were marital status, habitual snoring, diabetes mellitus, and hypertension.

Results: 249 (18%) participants had intermittent and 128 (9%) had persistent insomnia. In multivariate Cox proportional-hazards models, participants with persistent insomnia (adjusted Hazards Ratio [HR] 1.58, 95% CI: 1.02-2.45, P < 0.05), but not intermittent insomnia (HR 1.22, 0.86-1.74), were more likely to die. Analysis restricted to subjects not using hypnotics and subjects without pre-existent cardiovascular disease did not tangibly change results. Stratification by gender revealed the association between persistent insomnia and all-cause mortality to be present in both men and women. After adjusting for covariates, persistent insomnia was associated with cardiopulmonary mortality but not with cancer mortality.

Conclusion: In a population-based cohort, persistent insomnia over an eight-year period (and not intermittent insomnia) was associated with increased risk for all-cause and cardiopulmonary mortality independent of the effects of hypnotics, opportunity for sleep, and other potential confounding factors.

Support (If Any): 5R01HL095748, 5R01HL095021, and CADET award HL107188.

0498

INCREASED PHYSICAL ACTIVITY IMPROVES SLEEP AND MOOD OUTCOMES IN SEDENTARY PEOPLE WITH INSOMNIA: A RANDOMIZED CONTROLLED TRIAL

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Introduction: Lower levels of regular physical activity are an independent risk factor for insomnia incidence and prevalence. The impact of public health initiatives to increase physical activity on sleep outcomes of people with chronic sleep disorders remains mainly unexplored. The present trial was designed to investigate the effects on sleep quality of

increasing physical activity to currently recommended levels among sedentary people with insomnia.

Methods: 41 sedentary adults with DSM-IV insomnia symptoms (30 female; mean age 59.8 ± 9.5) were randomized to a physical activity group (≥ 150 minutes moderate intensity activity/week) or a waiting list control group. The principal end-point was Insomnia Severity Index (ISI) change 6 months post baseline; secondary outcomes were anxiety (STAI/Trait) and depression (Beck Depression Inventory). Physical activity was assessed using Actigraph GTX3+ accelerometers. Outcomes were assessed in univariate general linear models, adjusted for baseline confounders.

Results: Activity and sleep assessments did not differ at baseline. At 6 months post baseline the intervention group engaged in 213 min/week of moderate intensity PA, compared to the control group (82 min/week). Compared to the control group, the intervention group showed significant improvement in the ISI score at 6 months $F(1,28) = 5.16$, $p < 0.05$, adjusted means difference = 3.37, with an adjusted Cohen's $d = .78$ [95% CI .10-1.45]. There was a significant effects improvement in trait anxiety, and depression outcomes post-intervention, $F(6,28) = 4.41$, $p = 0.05$, and $F(6,28) = 5.61$, $p = 0.02$, respectively.

Conclusion: Increasing activity in line with current recommended World Health Organization guidelines can deliver clinically significant improvements in sleep quality and mood outcomes among sedentary people with insomnia.

0499

TREATING INSOMNIA IN THOSE WITH DEPRESSION: A RANDOMIZED CONTROLLED TRIAL

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Introduction: Antidepressant medications and psychological interventions are effective for treating major depressive disorder (MDD); however, they do not reliably address the insomnia suffered by most of their patients. There have been few studies conducted to test concomitant depression and sleep-focused therapies with MDD patients. One promising study showed that treating insomnia with cognitive behavioral therapy for insomnia (CBT-I) concurrently produces a superior antidepressant response to antidepressant medication alone. In the study below we attempted to replicate this finding.

Methods: Participants ($N = 66$; age 20-62 years old; M age = 41.5, $SD = 11.8$; 66.7% female) were those complaining of both insomnia and depression, who also met DSM-IV-TR criteria for major depressive disorder and an insomnia diagnosis, as assessed by the SCID and Duke Structured Interview for Sleep Disorders respectively. Participants completed study measures at baseline and post-treatment, including the Hamilton Depression Rating Scale (HAM-D17) and the Insomnia Severity Index (ISI). Participants were randomized into one of three treatment conditions over a period of 8 weeks: 1) escitalopram + sleep education, 2) CBT for insomnia + placebo antidepressant, or 3) escitalopram + CBT for insomnia.

Results: Based on their post-treatment sleep, patients were categorized as remitted from insomnia (REMIT-I) versus not (NO REMIT-I), and compared using a Chi square on the rate of depressive remission (as defined by a HAM-D17 score less than or equal to 7). The proportions of remission differed according to whether they had remitted from insomnia ($p < .05$). The rate of depressive remission in REMIT-I was 78% versus only 40% for NO REMIT-I.

Conclusion: The higher rate of depressive remission in those who remit from insomnia replicates previous findings. It would seem that treating insomnia (e.g., with CBT-I) as important for optimizing depression outcomes.

Support (If Any): National Institute of Mental Health.

0500

INSOMNIA WITH OBJECTIVE SHORT SLEEP DURATION AND ALL-CAUSE MORTALITY: GENDER EFFECTS

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Introduction: We have previously shown that insomnia with short sleep duration is associated with increased risk for cardiovascular morbidity (both genders) and mortality (only men). However, it was unclear whether gender differences in mortality were due to the low number of deceased women. We examined possible gender differences of insomnia with short sleep duration on mortality, while overcoming the methodological limitations of our previous study.

Methods: We addressed this question in the Penn State Adult Cohort, 1741 men and women who were studied in the sleep laboratory and followed-up for 18 y (men) and 14 y (women). "Insomnia" was defined by a complaint of insomnia with duration of ≥ 1 yr. Polysomnographic sleep duration was classified into two categories: ≥ 6 h (top 50% of the sample) and < 6 h (bottom 50% of the sample). We controlled for age, race, apnea-hypopnea index, depression, alcohol, smoking, obesity, hypertension, and diabetes.

Results: The mortality rate was 29.4% in men and 16.2% in women. We found a significant interaction between gender and insomnia on mortality [OR (95% CI) 0.43 (0.18-0.99)]; specifically, the mortality rate was significantly increased in men with insomnia (38.2%) but not in women with insomnia (14.6%). The highest odds of mortality in men were in those with insomnia and < 6 h [OR (95% CI) 2.77 (1.19-6.47)], compared to men without insomnia and ≥ 6 h. Further controlling for obesity, hypertension, and diabetes changed only slightly the association [OR (95% CI) 2.34 (1.00-5.48)].

Conclusion: Similarly to our previous report, insomnia with short sleep duration is associated with increased mortality in men. Gender differences in mortality associated with insomnia may be related to differences in the biological vulnerability associated with cardiometabolic morbidity that is adversely affected by this type of insomnia. Although insomnia is more prevalent in women, it appears that its impact is worse in men.

Support (If Any): NIH grants RO1 HL51931, RO1 HL40916, and RO1 HL64415.

0501

IMPROVED SLEEP QUALITY PREDICTS LONG-TERM IMPROVEMENTS IN SLEEP, PAIN, AND FATIGUE IN OLDER ADULTS WITH CO-MORBID OSTEOARTHRITIS AND INSOMNIA

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Introduction: In a primary care population of older adults (age 60+) with persistent osteoarthritis (OA) pain and insomnia, we examined the relationship between short-term improvement in sleep and long-term pain and fatigue outcomes through secondary analyses of randomized controlled trial data.

Methods: 367 study participants, regardless of experimental treatment received, were classified as either Improvers ($\geq 30\%$ baseline to

2-month (post-treatment) reduction on the Insomnia Severity Index [ISI] or Non-Improvers. Improvers did not differ from Non-Improvers on baseline covariates and baseline values of sleep, pain, fatigue, and other outcomes except for being two years younger ($p = 0.03$) and using more anti-depressant medications ($p = 0.02$). After controlling for treatment arm and potential confounders, outcome measures were examined at 9 and 18-month follow-up assessments.

Results: Improvers showed significant, sustained improvements in ISI ($p < .001$, -3.03 [-3.74 , -2.32]), Pittsburgh Sleep Quality Index Total ($p < .001$, -1.45 [-1.97 , -0.93]) and General Sleep Quality ($p < .001$, $-.28$ [$-.39$, $-.16$]) scores, Flinders Fatigue Scale ($p < .001$, -1.99 [-3.01 , -0.98]), and Dysfunctional Beliefs about Sleep ($p = .037$, -2.44 [-4.74 , -0.15]), but no improvements on the Functional Outcomes of Sleep Questionnaire or the Epworth Sleepiness Scale. Improvers also showed significant, sustained improvements across 18 months compared to Non-Improvers in Pain Severity ($p < .001$, Adjusted Mean Difference = -0.51 [95% Confidence Interval: -0.80 , -0.21]), Arthritis Symptoms ($p < .001$, 0.63 [0.26 , 1.00]), and Pain-Related Fear Avoidance ($p = .009$, -2.27 [-3.95 , -0.58]) but not in Pain Catastrophizing or Depression.

Conclusion: We conclude that short-term (2-month) improvements in sleep predicted long-term (9- and 18-month) improvements for multiple measures of sleep, fatigue and pain and that these improvements were not attributable to non-specific benefits for psychological well-being such as reduced depression. These findings are consistent with benefits of improved sleep for persistent pain and fatigue among older persons with osteoarthritis pain and co-morbid insomnia if robust improvements in sleep are achieved and sustained.

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0502

ASSOCIATIONS BETWEEN INSOMNIA PHENOTYPE AND CHRONICITY WITH WEEKLY TREATMENT RESPONSE DURING ONLINE CBT-I: OBSERVATIONS WITHIN A LARGE ONLINE TREATMENT COHORT

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Introduction: If insomnia phenotypes vary in their response to online CBT-I during treatment, more targeted therapeutic approaches for treatment-resistant phenotypes may be warranted.

Methods: We analysed routine data from adults who completed a 6-session CBT-I programme (Sleepio) and exceeded the Sleep Condition Indicator cut-off for Insomnia Disorder. 746 users met criteria for five insomnia phenotypes: difficulty initiating sleep (15.1%), difficulty maintaining sleep (34.7%), early morning awakening (8.7%), a combination of these three symptoms (32.3%) or nonrestorative sleep (9.1%). Chronicity of sleep problems was grouped into 4 categories (10 yr 38.5%). Treatment response was monitored using sleep efficiency (SE) at weekly intervals based on sleep diaries completed prospectively after session 1. Differences in treatment response over time were tested in repeated measures ANOVAs with SE as the within-subjects factor and i) phenotype ii) chronicity, as the between-subjects grouping factor. Significant time*group interactions, indicating a potential difference in treatment response, were explored using Bonferroni-adjusted post hoc comparisons within each time point.

Results: Overall mean SE was 49.2% at baseline, subsequently increased from S2 to S5 (67.0, 70.0, 77.8, 79.4%) and plateaued at S6 (79.1%) (SD \pm 12.6-14.5). There was a significant between-subjects effect of phenotype on SE and a significant time*phenotype interaction ($p < 0.001$). Mixed insomnia was associated with lower SE than the other phenotypes at all time points whereas users with nonrestorative

insomnia maintained a higher SE, except at S6. Low baseline SE was associated with a steeper increase in SE from S1 to S2 but after adjusting for baseline SE scores, the time*phenotype interaction was no longer significant ($p = 0.181$). Chronicity of sleep problems was not associated with between-subjects or time*chronicity effects. All users showed similar patterns of SE over time regardless of duration of symptoms.

Conclusion: Users showed similar patterns of sleep efficiency in response to an online CBT-I programme, regardless of insomnia chronicity or phenotype, suggesting that persistent insomnia or mixed symptoms are not contraindications to potential online CBT-I effectiveness.

0503

INSOMNIA WITH OBJECTIVE SHORT SLEEP DURATION AND INCIDENT CANCER

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Introduction: It has been shown that insomnia with objective short sleep duration is associated with increased risk for cardiovascular morbidity. However, its association with oncological morbidity is not well-established. We examined the joint effect of insomnia and objective short sleep duration on incident cancer.

Methods: We addressed this question in the Penn State Adult Cohort, 1620 men and women who were studied in the sleep laboratory, did not have cancer at baseline, and were followed-up after ~15 y. "Insomnia" was defined by a complaint of insomnia with a duration of ≥ 1 y. Polysomnographic sleep duration was classified as > 5 hours (top 75% of the sample) and ≤ 5 hours (bottom 25% of the sample). We controlled for sex, age, race, apnea-hypopnea index, obesity, hypertension, diabetes, alcohol, and smoking as well as depression.

Results: The rate of incident cancer was 12.3%. We found a significant interaction between insomnia and severe short sleep duration on incident cancer [OR (95% CI) 3.82 (1.11-13.1)]. Compared to the > 5 hour sleep duration group without insomnia, the highest odds of cancer were in the ≤ 5 hour sleep duration group with insomnia [OR (95% CI) 2.73 (1.24-6.04)]. After further controlling for depression, the association became marginally significant [OR (95% CI) 2.10 (0.92-4.78)].

Conclusion: Insomnia with severe short sleep duration is associated with increased odds of cancer, particularly in those with comorbid depression. Objective sleep duration may predict the medical severity of chronic insomnia, a prevalent condition whose morbidity and mortality risks have been underestimated.

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0504

NEUROPLASTICITY IN COMORBID CHRONIC PAIN AND CHRONIC INSOMNIA: IMPACT OF IMPROVED SLEEP ON CENTRAL SENSITIZATION

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Introduction: Central Sensitization [CS; increased responsiveness of dorsal horn neurons, and perhaps other CNS structures to stimuli] contributes to the maintenance of chronic pain. Sleep disturbance, which occurs in 50-88% of chronic pain patients, may play an etiological role in the development of CS. The Cognitive Activation Theory of Stress (CATS) provides a theoretical framework tying together chronic sleep

disturbance and chronic pain. Specifically, CATS posits that sustained arousal and lack of arousal resolution (i.e., through restful sleep) results in the development of CS. The present RCT examined the effect of improved sleep (as a result of cognitive-behavioral treatment of insomnia, CBT-I) on CS and pain.

Methods: 113 fibromyalgia patients with chronic insomnia (Mage = 57.93, SD = 8.88) were randomly assigned to 8 weeks of CBT-I, CBT for pain (CBT-P), or waitlist control (WLC). Two weeks of sleep and pain diaries and actigraphy, 1 night of ambulatory polysomnography, and thermal testing were collected at pre/post/6 mo-fu. A subset underwent pre/post fMRI/MRI (n = 33).

Results: A series of RM ANOVAs and follow-up analyses revealed greater improvements in subjective sleep continuity for CBT-I, followed by CBT-P, and then WLC at posttreatment (ESs = .8-WASO, .9-SE, .7-TWT, .5-SOL). Gains were well maintained at 6-months for CBT-I only. Similarly, improvements were clinically significant (SOL/WASO \leq 30 minutes and/or SE \geq 86%) for CBT-I only. There were no significant improvements in objective sleep (actigraphic, polysomnographic), clinical pain ratings or temporal summation of second pain. fMRI/MRI revealed a similar pattern of greater improvements in brain function (pain/sleep processing areas) and morphology [increased gray matter (thalamus, hippocampus); cortical thickness (6 regions, ps \leq .049)] for CBT-I, followed by CBT-P, and then WLC at posttreatment.

Conclusion: This study provides preliminary evidence that improving sleep (through CBT-I) may reverse CS. This is the first evidence of its kind. Future research examining how neuroplastic changes, brought about by sleep treatment, can restore healthy endogenous pain processes appears warranted.

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0505

THE INTERACTION BETWEEN STRESS AND SLEEP-REACTIVITY: A PROSPECTIVE INVESTIGATION OF THE STRESS-DIATHESIS MODEL OF INSOMNIA

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Introduction: In a previous report, we demonstrated that individuals with high 'sleep reactivity' i.e., the tendency to exhibit pronounced sleep disturbance in response to a sleep challenge, were at significantly higher risk for developing insomnia (RR = 1.77, 95% C.I. = 1.21-2.59) than those without this sleep-based vulnerability. The present study aimed to refine this finding by exploring the mechanisms by which a priori identified sleep reactivity among normal sleepers leads to incident insomnia.

Methods: 2892 adults (47.9 \pm 13.3 y; 59% female) with no current/lifetime history of insomnia completed the revised Social Readjustment Rating Scale (SRRS-R), a validated stress inventory. For each endorsed stressor on the SRRS-R, participants also completed the Intrusion subscale of the Impact of Events Scale. Finally, participants completed the Ford Insomnia Response to Stress Test (FIRST), a validated measure of trait sleep reactivity. Incidence of insomnia was measured at a one-year-follow-up.

Results: Stress exposure (OR = 1.13; p < .01) and stress-induced intrusion (OR = 1.61; p < .01) were significant risk factors for incident insomnia, with intrusion mediating the effects of stress exposure on risk for insomnia (PRODCLIN: 95% CI = .18-.49). Trait sleep reactivity was associated with a significantly increased risk for insomnia (OR = 1.78;

p < .01). Further, sleep reactivity moderated the effects of stress-induced intrusion on insomnia, such that the risk for insomnia as a function of stress-intrusion was significantly higher among individuals with high sleep reactivity (χ^2 = 3.96; p < .05).

Conclusion: The present study suggests that premorbid sleep reactivity is a strong and reliable risk factor for incident insomnia, and further that it triggers the disorder by exacerbating the effects of stress-induced cognitive intrusion. These findings offer cogent support for the stress-diathesis model of insomnia, while highlighting sleep reactivity as an important element in this diathesis.

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0506

MISPERCEPTION OF TIREDNESS IN INDIVIDUALS WITH INSOMNIA

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Introduction: Individuals with insomnia often display negative attributions of tiredness. Present research sought to use a novel method to determine whether individuals with insomnia also exhibit a misperception of their own facial representation of tiredness compared to normal sleepers. We also sought to determine whether awareness of misperception could improve accuracy of future attributions of tiredness.

Methods: Forty participants (20 with insomnia, 20 controls) were recruited. A photograph of their face was taken, which were then systematically edited into a series of five photos varying in degrees of tiredness-alertness, and developed into a seven second morph ranging from extreme-tiredness to extreme-alertness. After watching their personal morphs for \geq 20 seconds, participants were required to indicate the position on the morph that represented their current level of tiredness. (Mis) perception was calculated using a computer algorithm, and scored on a scale between 0 (perfectly accurate) to 100 (highly inaccurate). After responding, feedback on accuracy was provided. (Mis)perception scores were displayed and interpreted with consideration of their original and selected photographs. The procedure was repeated twice over a period of two consecutive days.

Results: Individuals with insomnia demonstrated greater misperception of tiredness than controls $F(1,38) = 10.26$, p = .003. Comparison of misperception from time 1 to time 2, irrespective of group, revealed a significant reduction in misperception of tiredness, $F(1,38) = 7.26$, p = .010. There was no significant interaction between group and time, p > .05, yet paired-samples t-tests revealed a significant reduction in misperception in the insomnia group only from time 1 to 2 (t(19) = 2.25, p = .036).

Conclusion: The present study demonstrated that individuals with insomnia exhibit a greater misperception of their facial representation of tiredness compared to controls. Moreover, providing feedback relating to their degree of misperception led to a reduction of such misperception. Current findings contribute to the understanding of negative attributions often characteristic of insomnia, suggesting that misperception can be reformed.

0507

IS THERE HABITUATION DURING SLEEP IN INSOMNIA INDIVIDUALS?

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Introduction: During normal sensory processing, the presentation of repetitive similar stimuli usually produces habituation. While not com-

monly studied during sleep, it is possible that individuals with insomnia not only exhibit greater responses to environmental stimuli at around sleep onset and/or during sleep, it is also possible they do not exhibit habituation. The present study evaluates habituation during sleep in individuals with insomnia and in good sleepers.

Methods: Archival data from an ERP study were used for the present analysis. Participants included 20 good sleepers (8M, age = 39.6 ± 9.6) and 20 medication free individuals suffering from insomnia. The latter group was comprised of 12 individuals with psychophysiological insomnia (5M, age = 44.5 ± 7.9) and eight individuals with paradoxical insomnia (3M, age = 41.7 ± 11.4). The protocol entailed the administration of auditory tones (both standard and deviant stimuli) at two second intervals for nearly 10 minute of trials per hour of sleep. The EEG responses within trains of consecutive standard tones (1 to 8th) were compared and ordinal averages for N1 and P2 were obtained. The amplitude of N1 and P2 ERP components respectively represent excitatory and inhibitory responses during early stage sensory processing.

Results: Repeated measures ANOVAs were conducted separately for each group by sleep stage (Early Stage 2, Late Stage 2, and REM sleep) for the peak values of N1 and P2. Significant amplitude differences ($p = .001$) were observed only for the good sleepers and neither of the two insomnia groups exhibited reduced amplitudes over time.

Conclusion: These results suggest (in contrast to good sleepers) that individuals with insomnia do not exhibit habituation during Stage 2 and REM sleep for auditory stimuli. Failure to habituate to auditory stimuli may be as, or more, contributory to sleep initiation and sleep maintenance problems than basal levels of “hyperarousal.”

Support (If Any): CIHR (CB;86571).

0508

CORTICAL AROUSAL IS PRESENT IN ALERT INSOMNIACS BUT ABSENT IN SLEEPY INSOMNIACS WITHIN SHIFT WORK DISORDER: AN ERP STUDY

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Introduction: Consistent with research showing hyperarousal in insomnia, we previously demonstrated cortical arousal in the insomnia-only phenotype of Shift Work Disorder (“alert insomniacs,” AI). Neurophysiologically, this cortical arousal is reflected by enlarged amplitude of the waking N1 ERP response. We now test whether cortical arousal is also present in night-workers with insomnia and excessive sleepiness (“sleepy insomniacs,” SI).

Methods: 12 AI (37.1 ± 11.0 years, ESS = 7.3 ± 2 ; ISI = 14.6 ± 3.1), 11 SI (36.6 ± 9.4 years, ESS = 11.2 ± 3.5 ; ISI = 14.2 ± 4.8), and 12 controls (32.8 ± 6.9 years, ESS = 6.7 ± 3.1 ; ISI = 4.9 ± 3.2) participated in an ERP, overnight MSLT, and phase assessment study. Subjects with a history of insomnia or other sleep disorders prior to shift work were excluded. The N1 responses to frequency-deviant [FD], duration-deviant [DD], and standard [STD] auditory stimuli were measured at a latency of 90-120 ms. The N1 peaks corresponding to each type of stimulus were compared by ANOVA. All other measures were compared between groups by t-tests.

Results: In AI, the peak of N1 to each stimulus was significantly ($p < 0.01$) enlarged (-1.5 ± 0.3 μ V [STD], -2.2 ± 0.9 μ V [FD] and -1.9 ± 0.6 μ V [DD]) over the frontal-central electrodes compared to SI (-0.9 ± 0.6 μ V [STD], -1.2 ± 0.6 μ V [FD], and -1.3 ± 0.6 μ V [DD]) and to controls (-0.9 ± 0.5 μ V [STD], -1.3 ± 0.7 μ V [FD] and -1.1 ± 0.6 μ V [DD]). N1 peaks were similar in SI and controls. MSLT was significantly ($p < 0.01$) lower in SI (3.1 ± 3.0) compared to AI (7.8 ± 5.1) and to controls (8.1 ± 3.4). DLMO was significantly ($p < 0.01$) later in controls ($04:54 \pm 3.7$ h) than in both SWD groups: AI ($22:45 \pm 4.9$ h) and SI ($20:55 \pm 4.6$ h).

ISI was correlated ($r = -.69$; $p = 0.01$) with N1 in AI group and was not correlated ($r = -.07$) in SI or controls.

Conclusion: Cortical arousal, reflected by enlarged N1 brain response, was observed in SWD patients with insomnia only, but not in the SI phenotype or in controls. This suggests that the “insomnia” in the SI phenotype is etiologically different from insomnia seen in the AI group.

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0509

TIME MONITORING BEHAVIOR: FACTOR ANALYSIS AND RELATIONSHIP TO SLEEP MEDICATION USE

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Introduction: Insomnia is associated with time monitoring behavior, or “clock watching,” and a desire for sleep medication. The present study assessed whether time monitoring behavior is associated with use of sleep medication.

Methods: Patients ($n = 4,886$) presenting for treatment at a sleep disorders center completed measures at intake including the 10-item Time Monitoring Behavior questionnaire (TMB-10), the Insomnia Severity Index (ISI), and reported the frequency of their use of medication for sleep. Patients were randomly assigned to one of three samples for subsequent analyses: exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and tests of mediation of the relationship between ISI and medication use. Significant mediation effects were tested for replication in the EFA and CFA samples.

Results: EFA revealed a three-factor solution for the TMB-10: Behavior, frustration during sleep initiation (SI-Frustration), and frustration during sleep maintenance (SM-Frustration). CFA showed good fit for the three-factor solution, $\chi^2(37) = 1345.86$, $p < .0001$, CFI = .9346, NFI = .9329. Of the entire sample, 48.77% reported weekly or greater use of any medication (prescription or over-the-counter) for sleep, while 26.2% reported weekly or greater use of prescription sleep medication. There were significant partial mediation effects of the relationship between ISI and use of any medication for sleep by both SI-Frustration and SM-Frustration, all $p < 0.05$, which were replicated in both the EFA and CFA samples. Mediation by Behavior was not significant, and mediation of prescription medication use by SI-Frustration and SM-Frustration did not replicate reliably.

Conclusion: Although medication use is influenced by myriad factors, frustration associated with time monitoring behavior at both sleep initiation and during sleep maintenance reliably explains part of the relationship between insomnia and use of sleep medications. Future research should explore whether decreases in time monitoring behavior are associated with decreases in sleep medication use.

Support (If Any): Maimonides Sleep Arts and Sciences, and the Sleep & Human Health Institute.

0510

NIGHT TO NIGHT VARIABILITY AMONG OLDER ADULTS WITH INSOMNIA: ASSOCIATIONS WITH SLEEP QUALITY AND DIABETES RISK

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Introduction: Aging is associated with increased variability in many physiologic processes, including sleep wake behavior as well as increased prevalence of insomnia. The goal of this study was to test the

relationship between variability in objective rest/activity measures with measures of subjective sleep quality and diabetes risk in older adults with insomnia participating in a non-pharmacologic intervention.

Methods: Seventeen older adults with primary insomnia and sleep duration ≤ 6.5 hours received one session of sleep hygiene education and were randomized to 16 weeks of aerobic exercise or non-physical activities, 3–4 times per week. Objective rest/activity variables (sleep onset time, sleep offset time, sleep duration, fragmentation index) were estimated using wrist actigraphy. Sleep onset latency and sleep efficiency were calculated using actigraphy and sleep diaries. Variability was defined as standard deviation of actigraphy variables. Subjective sleep quality assessed with the Pittsburgh Sleep Quality Index (PSQI); daytime sleepiness was measured by the Epworth Sleepiness Scale (ESS); and V02Max was measured using treadmill exercise testing. Markers of diabetes risk included fasting glucose, glycosylated hemoglobin (HbA1c) and body mass index (BMI).

Results: At baseline, variability in sleep latency ($r = .56$, $p = .04$), sleep efficiency ($r = .62$, $p = .01$), WASO ($r = .51$, $p = .04$), and fragmentation index ($r = .54$, $p = .03$) were associated with higher PSQI scores. Greater variability in sleep duration ($r = .644$, $p = .02$) and sleep offset ($r = .56$, $p = .06$) were associated with higher HbA1c. Greater variability in sleep onset was associated with higher BMI ($r = .52$, $p = .03$). Variability in sleep efficiency decreased from baseline to 16 weeks ($p = .03$) in both groups. Improvement in sleep efficiency variability was associated with improvement in fasting glucose ($r = -.60$, $p = .04$).

Conclusion: Variability in sleep was highly correlated with self-reported sleep quality and associated with markers of increased diabetes risk among older adults with insomnia. Improving variability in sleep may improve sleep quality as well as disease risk.

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0511

MODERATORS AND MEDIATORS OF THE RELATIONSHIP BETWEEN STRESS AND INSOMNIA: STRESSOR CHRONICITY, COGNITIVE INTRUSION AND COPING BEHAVIORS

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Introduction: Most studies characterize the relationship between stress exposure and insomnia as a simple dose-response phenomenon. However, recent research suggests that stress characteristics such as the perceived severity/chronicity of a stressor moderate the impact of stress. Similarly, an individual's 'response' to a stressor is a mediator or mechanism by which stress translates into pathology. Common responses to stress include intrusive cognitions about the stressor and coping behaviors undertaken to meet its demands. The present study aimed to assess the role of such moderators and mediators in the prospective association between naturalistic stress and incident insomnia.

Methods: 2892 adults (47.9 ± 13.3 yo; 59% female) with no current/lifetime history of insomnia completed the revised Social Readjustment Rating Scale (SRRS-R), a validated stress inventory. For each endorsed stressor on the SRRS-R, participants also reported: perceived severity; chronicity; consequent cognitive intrusion; and coping behaviors. Incidence of insomnia was measured at a one-year-follow-up.

Results: Logistic regression analyses revealed that stress exposure was a significant predictor of insomnia onset, such that the odds of developing insomnia increased by 19% for every additional stressor ($\chi^2 = 51.11$; $p < .01$). Chronicity significantly moderated this relationship, such that the likelihood of developing insomnia as a result of stress exposure increased as a function of chronicity ($\chi^2 = 8.28$; $p < .01$). PRODCLIN

mediation analyses suggested cognitive intrusion significantly mediated (69% of the total effect; $p < .05$) the association between stress exposure and insomnia. Finally, three specific forms of coping also acted as mediators: behavioral disengagement (91%; $p < .05$), distraction (86%; $p < .05$), and substance use (21%; $p < .05$).

Conclusion: Our data suggest that stressor characteristics moderate the association between stress and insomnia. Similarly, stress response in the form of cognitive intrusion and maladaptive coping behaviors mediate these effects. These findings highlight the need for a multidimensional approach to stress assessment.

Support (If Any): This study was supported by an NIMH Grant R01 MH082785 to Dr. Christopher L. Drake.

0512

COMPLAINING GOOD SLEEPERS VERSUS COMPLAINING POOR SLEEPERS: WHO IS MORE HOPELESS?

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Introduction: Past research has demonstrated that insomnia is a predictor of suicidality. However, the relation between insomnia and hopelessness, a robust predictor of suicidality, has received little research attention. Prior research with the present sample has identified insomnia as a predictor of hopelessness. However, it is unclear whether individuals who report insomnia in the absence of disturbed sleep experience hopelessness to the same degree as those who meet conservative criteria for insomnia.

Methods: Using random-digit dialing, we recruited 771 participants ranging in age from 20 to 80+, with approximately 50 men and 50 women in each decade. Participants completed 2 weeks of sleep diaries and measures of daytime functioning, including the Beck Depression Inventory (BDI). BDI item 2 was used to assess hopelessness. The present sample included 233 participants who complained of insomnia. The sleep diaries of 149 of these participants ("complaining poor sleepers") satisfied quantitative criteria for insomnia. The remaining 84 participants ("complaining good sleepers") did not meet quantitative criteria for insomnia.

Results: A chi square analysis was not significant $\chi^2[2] = 2.02$, $p = .364$, indicating that complaining good sleepers do not differ from complaining poor sleepers in their degree of hopelessness.

Conclusion: This finding indicates that individuals who present with a complaint of insomnia in the absence of poor sleep experience similar levels of hopelessness to individuals who complain of insomnia and experience poor sleep. This is consistent with previous research showing that a complaint of insomnia predicts depression independently of sleep parameters. Given previous research linking hopelessness to suicidality, the present finding suggests that complaining good sleepers may be comparable to complaining poor sleepers in their degree of suicide risk.

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0513

THE ROLE OF VULNERABILITY TO STRESS-RELATED INSOMNIA, SOCIAL SUPPORT, AND COPING STYLES ON INCIDENCE AND PERSISTENCE OF INSOMNIA

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Introduction: Individuals who are more prone to experience situational insomnia under stressful conditions may also be at greater risk to develop subsequent persistent insomnia. While cross-sectional data exists on the link between sleep reactivity (heightened vulnerability to stress-related insomnia) and insomnia, limited data on its predictive value exist. The aim of the study was to prospectively evaluate whether sleep reactivity was associated with increased risk of incident insomnia symptoms or syndrome as well as persistent insomnia in a population-based sample of good sleepers. Social support and coping styles were also investigated as potential moderators.

Methods: Participants were 1449 adults (Mage = 47.4, SD = 15.1; 41.2% male) without insomnia at baseline and evaluated four times over a 3-year period. Sleep reactivity was measured using the Ford Insomnia Response to Stress Test (FIRST). Measures of depressive symptoms, frequency and perceived impact of stressful life events, social support, and coping styles were also assessed. Incident insomnia cases were required to meet criteria for insomnia symptoms or syndrome at one of the follow-up evaluations. A persistent insomnia case was required to meet the criteria for insomnia symptoms or syndrome for at least two consecutive follow-up evaluations.

Results: After controlling for prior history of insomnia, depressive symptoms, stressful life events and perceived impact, individuals with higher sleep reactivity had an OR of 1.67 (95%CI: 1.22-2.30), of developing incident sub-syndromal insomnia, 1.43 (95%CI: 0.88-2.31) of developing incident syndromal insomnia, and 2.10 (95%CI: 1.35-3.26) of having persistent insomnia. Social support and coping styles did not moderate these associations.

Conclusion: Results suggest that heightened vulnerability to insomnia is associated with an increased risk of developing new onset sub-syndromal and persistent insomnia in good sleepers. Knowledge of premorbid differences is important to identify at-risk individuals, as this may help develop more targeted prevention and intervention strategies for insomnia.

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0514

INTER-RELATIONSHIPS BETWEEN PRE-SLEEP AROUSAL, MOOD AND ALEXITHYMIA AMONG NORMAL SLEEPERS

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Introduction: Mood affects sleep (c.f. Baglioni et al., 2010), and the trait of alexithymia could also contribute towards poor sleep (De Gennaro et al., 2004), with conflicting results reported in healthy subjects (De Gennaro et al., 2004; Bazydlo, Lumley, and Roehrs, 2001). In normal sleepers this relationship could be subtle, and linked to mood. As pre-sleep arousal is known to contribute towards poor sleep (Morin, Rodrigue and Ivers, 2003), we hypothesize that greater alexithymia contributes towards greater pre-sleep arousal.

Methods: Data from 87 well-screened normal sleepers (NS; 54F, 33M), mean age 22.29 (SD = 3.82, range 18-38) were analyzed. All subjects reported normal sleep habits, with no evidence of mood disorders. Participants completed a questionnaire battery, which comprised the Toronto

Alexithymia Scale (TAS-20), the Pre-Sleep Arousal Scale (PSAS), and the Global Vigor and Affect Schedule (GVAS).

Results: A median split on alexithymia scores suggests that low scorers evidence less pre-sleep arousal (both somatic and cognitive, $p < 0.001$), and higher mood (Global Affect, $p < 0.005$; Global Vigor, $p < 0.05$). Correlational analyses confirmed these results of the TAS-20 and PSAS (PSAS-S: $\rho = 0.43$, $p < 0.001$) and PSAS-C ($\rho = 0.39$, $p < 0.001$). Negative correlations were found for GV ($\rho = -0.37$, $p < 0.001$) and GA ($\rho = -0.33$, $p < 0.005$). GV was linked to PSAS-S ($\rho = -0.39$, $p < 0.001$) and PSAS-C ($\rho = -0.41$, $p = 0.07$).

Conclusion: Results suggest that even in normal sleepers without insomnia, high scorers on alexithymia report significantly higher levels of pre-sleep arousal and lower mood, suggesting relationships between them; results which may be in keeping with the importance of the inhibition of de-arousal (Espie, 2002).

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0515

THE DIFFERENTIAL CONTRIBUTION OF INSOMNIA SYMPTOMS TO HYPERTENSION

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Introduction: Though prior research suggests that chronic insomnia confers increased risk for hypertension, the extant literature offers limited insight into the specific insomnia symptoms that may mediate this relationship. Different insomnia symptoms, including sleep onset difficulties, sleep maintenance difficulties, and early morning awakening, are clinically distinguishable and stable in nearly 50% of insomnia patients. Therefore, the present study aimed to assess the prospective effects of insomnia phenotypes on risk for hypertension.

Methods: A sample of 906 adults (43.3 ± 13.2 yrs; 71.6% female) with RDC established diagnoses of insomnia disorder but no current/lifetime history of hypertension completed questionnaires assessing medical/psychosocial history as well as sleep parameters, including sleep onset latency, total sleep time, number of awakenings, and wake time after sleep onset. Incidence of hypertension was measured at a one-year-follow-up.

Results: Follow-up assessment revealed 36 new cases of hypertension (one-year incidence rate: 4%). Logistic regression analyses controlling for BMI and risk for obstructive sleep apnea (as measured by the Berlin Questionnaire) revealed a significant association between change in number of nocturnal awakenings and risk for hypertension (OR = 1.05; 95% CI = 1.01-1.10; $p < .05$). Specifically, odds of developing hypertension increased by 5% for each increase in awakening from baseline to follow-up. The relationship between total sleep time (TST) and risk for hypertension approached significance ($p < .07$), such that shorter TST was predictive of higher risk. None of the other sleep parameters (e.g. sleep onset latency, sleep quality) were significant predictors of follow-up hypertension.

Conclusion: Our data suggest that specific changes in sleep maintenance (number of awakenings) may be uniquely related to risk for hypertension. Future studies should measure the objective physiological manifestations (e.g., CNS Norepinephrine) of nocturnal awakenings to determine underlying mechanisms.

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0516

STRESS RELATED SLEEP DISTURBANCES ARE RELATED TO METACOGNITION AND DEPRESSION IN PRIMARY INSOMNIA

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Introduction: It has been shown that a measure of stress-related sleep reactivity is associated with greater sleep disruption on the first night in the laboratory. These data support the hypothesis that insomnia or poor sleep quality can be related to individual differences in vulnerability to stress. It has also been hypothesized that this vulnerability is associated with physiological hyperarousal. The aim of the study is to identify in primary insomnia (PI) relationships between poor sleep quality, sleep reactivity to stress, and depressive symptomatology, since depression per se is a stress-related disorder.

Methods: Nineteen PI patients (10 females, mean ages 50+4 yrs) were recruited from the Psychiatric Units of Pisa University. Five questionnaires were administered to each subject assessing: 1) sleep quality (Pittsburgh Sleep Quality Index, PSQI); 2) stress-related sleep reactivity (Ford Insomnia Response to Stress Test, FIRST); 3) metacognition (Metacognition Questionnaire-Insomnia, MCQ-I); 4) depressive symptoms (Beck Depression Inventory, BDI); 5) anxiety levels (Zung Self-Rating Anxiety Scale, SAS). The relation between each measure and gender (ANOVA on ranks) and age (Spearman correlation) were assessed. PSQI, FIRST, MCQ-I, BDI and SAS, were then submitted to a Principal Components Analysis (PCA).

Results: There were no significant effects for gender or age. PCA yielded two components, PC1 and PC2 (41% and 31% of total variance, respectively). MCQ-I, BDI and FIRST had significant loadings on PC1 (0.88, 0.81, 0.71) while PSQI and SAS on PC2 (0.84, 0.73).

Conclusion: These findings suggest three potential implications: i) Sleep reactivity may be a construct more closely related to depression than anxiety in insomnia. ii) Cognitive traits like metacognition favor intrusive thoughts which may relate to subsequent sleep reactivity in response to stressors. iii) Sleep quality is more impaired at higher anxiety levels. If these findings are confirmed, they could help design therapeutic strategies for insomnia, acting selectively on stress reactivity.

0517

PRESCRIBING PATTERNS OF SEDATIVE HYPNOTICS FOR THE TREATMENT OF INSOMNIA AMONG VETERANS: 2001-2011

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Introduction: Prescription medications—sedative hypnotics—remain the primary treatment for insomnia. New medications, increased availability of generic medications, and off-label use of drugs has resulted in changing patterns in the past decade. Prescribing patterns of sedative hypnotic medications will be explored.

Methods: Medication data from a large cohort of Veterans (n = 38,988) was used to explore prescribing patterns. Veterans who received services at VA Pittsburgh Healthcare System (VAPHS) in the calendar year 2007

were included. Veterans were tracked retrospectively until entry into VAPHS and prospectively until December 31, 2011. Sedative hypnotics were determined with clinicalpharmacology.com and the VA Pharmacy Benefits Management recommendations to identify medications indicated for the treatment of insomnia, on-label or off-label. Medications were grouped as List A, which represented all sedative hypnotics, and List B, which represented non-benzodiazepine receptor agonists (e.g., zolpidem) and low-dose trazodone.

Results: Lifetime sedative hypnotic use increased over time from approximately 19% in 2001 to 61% in 2011 (List A) and 10% in 2001 to 23% in 2011 (List B). New prescriptions of List A and B drugs peaked in 2006. Total prescriptions of zolpidem increased by 61% from 2001 to 2003 (n = 550-885) followed by a 42% drop. From 2004 to 2011, yearly zolpidem prescriptions increased by 302% (n = 509-1536). Comparatively, trazodone (tr) and temazepam (te) also initially peaked in 2003 (tr = 7301; te = 2925) with significant decreases of 52% and 47%, respectively, over the following two years. Both peaked again in 2006 (tr = 6706; te = 2732) followed by significant decreases of 42% and 34%, respectively, from 2007-2011.

Conclusion: Despite new and total prescriptions of List A and B drugs decreasing since 2006, zolpidem prescriptions continue to increase. This pattern suggests the continued need for increased dissemination and implementation of non-pharmacological interventions for insomnia, such as brief behavioral and cognitive behavioral treatments for insomnia.

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0518

FRONTAL SLEEP SPINDLES IN INSOMNIA: AN EXPLORATORY STUDY

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Introduction: It has been shown that cortical hyperactivation is present in insomnia sufferers (INS) compared to good sleepers (GS). This hyperactivation might affect sleep protection mechanisms in reducing the occurrence of sleep spindles. The objective of this study was to document the microstructure of stage 2 sleep in INS (subdivided in paradoxical 'PARA-I' and psychophysiological 'PSY-I') and in GS by comparing the occurrence of frontal sleep spindles in each group.

Methods: 12 PARA-I (mean age = 37.1 ± 9.5), 12 PSY-I (35.4 ± 8.8) and 12 GS (30.9 ± 5.5) completed four consecutive PSG nights. To determine whether differences exist between groups, frontal sleep spindles were manually scored during stage 2 sleep on nights 2 and 3. The early and late portions of the night were analyzed independently. Total number of sleep spindles and density (number of sleep spindles per minute) were calculated. Spindles lasting between 0.5 and 1.5 seconds, having a frequency from 11 to 15 Hz and amplitude ranging from 20 to 40 µV were included.

Results: Repeated measures ANOVAs revealed no significant difference between INS and GS according to the density (p > .05) of frontal sleep spindles. Subsequently, additional repeated measures ANOVAs performed between PARA-I, PSY-I and GS showed no significant effect of groups on the density of frontal sleep spindles (p > 0.05). Independent samples t tests revealed no effect of time or night on the occurrence of sleep spindles. Finally, Pearson correlations between subjective and objective sleep quality with density of frontal sleep spindles revealed no significant differences (p > 0.05).

Conclusion: These results suggest that sleep protection mechanisms, expressed by the presence of sleep spindles, are similar in both types of INS and GS, supporting the idea that they do not seem deficient in INS. Moreover, hyperactivation in INS doesn't seem linked to sleep spindles.

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0519

RELATIONSHIP BETWEEN AFFECT AND INSOMNIA SEVERITY FOLLOWING COGNITIVE-BEHAVIORAL TREATMENT OF INSOMNIA

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Introduction: Sleep and affect are related in complex, bidirectional ways. We examined whether changes in negative and positive affect were related to changes in insomnia severity, and vice versa, following treatment with CBT-I.

Methods: Participants were 62 adults (mean age = 51.68; range = 26 to 79) with insomnia disorder (determined via clinical interview) presenting for treatment at a university sleep center. Participants completed self-report measures of affect (derived from the Profile of Mood States) and insomnia severity (Insomnia Severity Index) at baseline and following 6 sessions of group CBT-I.

Results: At baseline, insomnia severity was significantly related to both negative ($r = .51$, $p < .001$) and positive affect ($r = -.31$, $p < .05$). Negative affect ($t = 4.74$), positive affect ($t = -3.36$), and insomnia severity ($t = 12.66$) significantly changed from pre- to posttreatment (all $ps < .001$). Multiple regression was used to evaluate the unique association of pre to post changes and post-treatment levels of affect and insomnia severity. After adjusting for baseline levels of negative affect, positive affect, and insomnia severity pre-post changes in negative affect were significantly associated with posttreatment insomnia severity ($B = -.37$, $p < .05$) while pre-post changes in positive affect were not ($B = -.07$, $p = .60$). Similarly, after adjusting for baseline levels of negative affect and insomnia severity, pre-post changes in insomnia severity were significantly associated with posttreatment negative affect ($B = -.31$, $p < .01$). Posttreatment positive affect was not associated with pre-post changes in insomnia severity after adjusting for baseline levels of positive affect and insomnia severity ($B = .08$, $p = .53$).

Conclusion: Results support a reciprocal relationship between negative affect and insomnia severity. Negative affect appears more strongly associated with insomnia severity than positive affect. The addition of interventions targeting negative affect might help to improve insomnia outcomes.

0520

A QEEG BIOMARKER IN PRIMARY INSOMNIA AND OBSTRUCTIVE SLEEP APNEA PATIENTS

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Introduction: Insomnia and obstructive sleep apnea (OSA) are the two most common sleep disorders that lead to daytime functional impairments and memory/learning problems. However, detailed electrophysiology of insomnia and OSA hasn't been yet understood clearly, which was the key motivation of this study.

Methods: Polysomnographic data of 15 primary insomnia (PIN) patients (52.6 ± 13.0 yrs; 8 males, AHI < 5/h) and age-matched 36 OSA

patients (57.6 ± 6.1 yrs; 25 males, AHI = 27.0 ± 17.8) were analyzed. For each 30 s epoch, spectral power in the delta band (0.5–4.5 Hz) was calculated. The time series of EEG delta power were rescaled to explore group differences.

Results: The sleep efficiency (%) and proportion of REM sleep (%) were significantly reduced in PIN, compared with OSA (70.9 ± 12.4 vs. 80.9 ± 11.0 , $p < 0.01$; 17.1 ± 5.4 vs. 40.6 ± 19.0 , $p < 0.01$, respectively). The EEG delta power (%) of whole nights showed no significant difference (78.7 ± 10.6 vs. 81.6 ± 7.5 , $p = 0.06$). However, the PIN showed reduced delta power, predominantly in the early and late sleep (50.0 ± 11.7 vs. 74.3 ± 4.7 , $p < 0.01$ during the first 50 min; 59.2 ± 7.8 vs. 71.5 ± 4.4 , $p < 0.01$ during the last 50 min).

Conclusion: The reduced EEG delta power in PIN during the early sleep can be understood as the outcome of prolonged sleep onset period, while the difference in the late sleep may be associated with the difficulty in maintaining sleep or early morning awakening in primary insomnia. Time courses of EEG delta power through night quantitatively differentiated PIN from OSA patients and it may be associated with subjective symptoms in primary insomnia.

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0521

TESTING THE SLEEP HYGIENE RECOMMENDATION AGAINST NIGHTTIME EXERCISE

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Introduction: Physical exercise is recognized as one of the tools for better sleep. However, one of the caveats for this topic is that nighttime exercise is liable to disrupt sleep. The aims of this study were to investigate the effects of acute nighttime exercise on sleep in a group of relatively inactive adults with insomnia, and to assess whether changes in sleep were correlated with changes in state anxiety, core body temperature and heart rate variability (HRV).

Methods: Twelve insomniacs (age 27 ± 6.8) completed each of two treatments in a within-subjects, counterbalanced design. (1) An exercise treatment consisted of 30 min of treadmill running/walking at a moderate intensity followed by 15 minutes of moderately intense resistance exercise. (2) A sedentary control treatment involved reading for 60 min. The treatments were completed 2 hours before bedtime, and sleep was assessed over fixed 8-hr periods with polysomnography (PSG) and a subjective sleep questionnaire. Spielberger State Anxiety Inventory (STAI) was assessed before and 30 minutes after the treatments, and 10 minutes before bedtime. Core body temperature and HRV were assessed during the sleep period. The treatments were compared and correlations of sleep with changes in STAI, temperature, and HRV were assessed.

Results: There was no significant difference in PSG data between the exercise [Sleep latency (SOL) 16 ± 23 min, TST 388 ± 104 min] and reading treatments (SOL 20 ± 41 min, TST 401 ± 73 min), nor in any of the subjective sleep variables. HR and HRV during the night did not differ between the sessions. We observed a significant increase in core body temperature during the exercise session (Exercise 37.633 ± 0.089 °C, Reading 37.175 ± 0.147 °C), but no significant differences were detected across the sessions for sleep periods. No significant differences were found for STAI, but there was a moderate correlation between the WASO and change of STAI ($p = 0.002$, $r = 0.645$).

Conclusion: Moderate physical exercise completed 2 hours before bedtime didn't aggravate insomniacs' sleep. This study also showed that the

change of anxiety from before the session to before bedtime was related to WASO.

Support (If Any): This study was supported by grants from National Sleep Foundation.

0522

ENHANCED BETA AND GAMMA WAKING ACTIVITY AND INTRAHEMISPHERIC SYNCHRONIZATION AFTER SLEEP IN PRIMARY INSOMNIACS

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Introduction: Subjective feelings of insufficient and non-restorative sleep are core symptoms of psychophysiological and paradoxical insomnia. Quantitative analysis of EEG activity has demonstrated a restorative effect of sleep on next day waking EEG activity, decreasing power and intrahemispheric synchronization of fast activity, whereas sleep deprivation has non-restorative effects on next day waking EEG activity. We investigated if subjective feelings of non-restorative and insufficient sleep in patients with primary insomnia compared to control subjects are associated with increased power and decreased temporal coupling in next day waking activity.

Methods: We analyzed spontaneous waking EEG activity (10-20 system) with eyes closed before going to sleep (10-11 pm) and after a night of sleep (10-11 am) in 10 right-handed non-medicated primary insomniacs (19-34 years old), carefully screened for primary insomnia with no other sleep/medical condition (psychiatric, medical and sleep examination, and polysomnography) and in 10 controls matched for age, dexterity and education. EEG was digitized (1024 Hz). Power, EEG correlation and source density (VARETA) were obtained for artifact-free two sec non-overlapping EEG epochs. Participants also evaluated subjective sleep quantity and quality.

Results: There were no significant differences between groups in polysomnographic variables; however, insomnia patients evaluated their sleep as non-restorative and insufficient. Compared to pre-sleep, control subjects exhibited significantly lower beta and gamma power in the left hemisphere after sleep. Whereas, in insomnia patients beta and gamma activity after sleep remained at the same levels as before sleep. Synchronization of beta and gamma activity between left posterior association areas and midline regions, involved in self awareness, also decreased from pre-sleep to post-sleep values in the control group and remained higher in the insomnia patients.

Conclusion: These findings suggest a non-restorative sleep that may be involved in subjective complaints of insufficient and poor sleep in primary insomniacs with objective signs of sleep.

0523

ETHNICITY AND ZOLPIDEM SLEEP EFFECTS IN INSOMNIA

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Introduction: Studies have reported reduced % stage 3-4 sleep in middle-aged African-Americans (AA) compared to Caucasians (CAU) and insomniacs compared to age-matched controls. In a post hoc analysis of data assessing one-year zolpidem efficacy and safety in chronic insomnia, we evaluated ethnicity effects.

Methods: Insomniacs (N = 78) meeting DSM-IV-TR criteria, ages 23-70, without psychiatric disease or drug dependency were recruited. Insomniacs had a screening NPSG sleep efficiency of $\leq 85\%$. Participants

were randomly assigned to receive 10 mg zolpidem or placebo, double blind for 12 consecutive months. On 2 consecutive nights in months 1 & 8, zolpidem sleep effects were assessed with an 8 hr NPSG. The data were analyzed by ethnicity [AA (n = 49), CAU (n = 29)], comparing zolpidem (n = 36) versus placebo (n = 42). AA were aged 55.3 ± 6.0 yrs and CAU 56.3 ± 8.3 yrs.

Results: Zolpidem 10 mg increased SE (p = 0.001) and reduced, LPS (p = 0.002) and WASO (p = 0.004) in months 1 and 8. There were no main effects of ethnicity and no zolpidem by ethnicity interactions on these efficacy measures. There were no main effects of ethnicity or zolpidem effects on any of the sleep stage percentages. But, a zolpidem by ethnicity interaction on stage 3-4 % was found, corrected using screening % 3-4 as a covariate (p = 0.03). Over both months 1 and 8 relative to placebo, zolpidem suppressed % 3-4 sleep in AA (Pbo: 8.3 vs Zol: 2.8%), but had no effects on % 3-4 sleep in CAU (Pbo: 5.0 vs Zol: 8.6%).

Conclusion: There were no ethnicity differences in basal sleep or zolpidem efficacy, but these data showed suppression of stage 3-4 sleep in AA with zolpidem 10 mg. Mechanisms for this effect are currently unknown.

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0524

SEX INFLUENCE ON SLEEP ARCHITECTURE FOLLOWING TREATMENT OF PATIENTS WITH MIDDLE-OF-THE-NIGHT INSOMNIA WITH BUFFERED SUBLINGUAL ZOLPIDEM OR PLACEBO

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Introduction: Hypnotic medications can impact sleep architecture; barbiturates suppressed REM sleep (REMS), while benzodiazepines suppressed Stage 3-4 (SWS). Benzodiazepine receptor agonists like zolpidem increase stage 2 and REM latency. Previous research, however, used bedtime dosing and generally did not analyze data by sex of subject. The first half of the night is primarily enriched with SWS, and the last half with REMS. A buffered zolpidem sublingual formulation (ZST) is approved for administration in the middle-of-the-night (MOTN) by patients with MOTN insomnia (and at least 4 h of bedtime remaining). These post-hoc analyses determined whether pharmacologic, sex, and circadian influences affect sleep stages following MOTN administration of ZST.

Methods: Double-blind, placebo-controlled 3-way cross-over sleep laboratory polysomnography study evaluated patients with primary insomnia whose chief complaint was MOTN awakenings with difficulty returning to sleep. 58 female and 24 male patients were randomized. Patients were dosed with 3.5 mg, 1.75 mg or placebo 4 h after lights out, kept awake for 30 min, then returned to bed for 4 h. Sleep stages were scored centrally by standardized criteria in 30 second epochs for 4 h pre- and postdose. An ANCOVA model was applied.

Results: Postdose, there was a dose-dependent change in NREM sleep. Percent of light stage 1 decreased slightly, while percent of deeper stages 2 and SWS increased significantly overall for 3.5 mg (p < 0.02, p < 0.003 respectively), accounted for primarily by female subjects (p < 0.01, p < 0.002, respectively). % REMS declined slightly but significantly (p < 0.0001) for 3.5 mg, more prominently in females (p < 0.001). The overall improvements in sleep quality reported by patients on mornings postdosing in the ZST outpatient study may be related to the differential effects in NREM sleep stages.

Conclusion: After MOTN dosing, sleep after ZST included all sleep stages, including SWS typically not observed in the latter half of the night. These findings may relate to ratings of sleep quality.

Support (If Any): Purdue Pharma LP and Transcept Pharmaceuticals, Inc.

0525

PERIODIC LIMB MOVEMENTS IN SLEEP BY
POLYSOMNOGRAPHIC STUDY IN BREAST CANCER
SURVIVORS

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Introduction: Insomnia is frequent among cancer survivors. Twenty-six breast cancer survivors participated in a sleep laboratory study.

Methods: Patients completed self-report questionnaires and slept 2 nights in the sleep laboratory. PSG data (Night 2) was scored using AASM criteria. Patients fell into two groups by PSQI scores: None/Mild Sleep Disturbance (Gp-1, PSQI score ≤ 9 , N = 15) or Moderate/Severe Sleep Disturbance (Gp-2, PSQI score > 10 , N = 11). Data were analyzed by chi-square or t-test with correction for unequal variances.

Results: Patients in the two groups were similar in age (range 39-80, median 54 years), time post-treatment (59.3 ± 22.2 vs. 46.7 ± 27.2 months, NS) and cancer stage at diagnosis (stage I to stage IIIB). All were disease free at study onset, except one patient in Gp-1 with stable disease (Stage IIA). Cancer treatment consisted of surgery followed by chemotherapy, radiation and hormonal therapy as clinically indicated. At time of study, about half of the patients in both groups were still on hormonal treatment. SOL, TST, sleep efficiency, awakenings, arousals and WASO were not different between groups. The parameter that differentiated the two groups was periodic leg movements (PLMs). PLMs were dramatically higher in the Gp-2 (121.8 ± 163.0) versus Gp-1 (24.1 ± 39.6 , $P = .078$). Log transformation of PLM counts resulted in a significant t-test between groups ($P = .008$). Correspondingly, the PLM Index was much increased in the more severe insomnia group (Gp-2, 19.6 ± 27.7 vs. 3.6 ± 5.9 in Gp-1, milder cases, $P = .086$). 45% of subjects in Gp-2 vs. 7% in Gp-1 had a PLMI > 15 ($P = .02$). Arousals caused by PLMs were higher in Gp-2 (4.4 ± 6.0) than in Gp-1 (0.8 ± 1.3 , $P = .075$).

Conclusion: Periodic limb movements in sleep are a physiological phenomenon corresponding to the subjective complaint of moderate to severe insomnia in some breast cancer survivors.

Support (If Any): Breast Cancer Research Foundation; National Sleep Research Institute; CCTS, Rockefeller University.

0526

A LONGITUDINAL TWIN STUDY OF INSOMNIA SYMPTOMS
IN ADULTS

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Introduction: Insomnia is a prevalent sleep disorder that is associated with negative medical and psychiatric consequences. Epidemiologic studies demonstrate sex and age differences in insomnia prevalence, and a growing literature suggests that insomnia is moderately heritable. However, few genetically informative longitudinal studies of both sexes exist. Thus, questions remain with regard to the stability of the genetic influence on this phenotype across time, as well as the potential for genetically based sex differences.

Methods: Data from the Virginia Adult Twin Study for Psychiatric and Substance Use Disorders (n = 7,500) was used for analyses. Past month insomnia was assessed at two time points with the shortened version of

the Symptom Checklist-90 scored on a 5 point scale. A composite score for the sleep items was calculated and used in analyses. Twin modeling is being conducted in OpenMx, and will be completed by the time of presentation. The phenotypic variance will be decomposed into additive genetic factors (A), common environmental factors (C), and individual specific environmental (E) sources. A longitudinal measurement model will be fitted that examines stability of genetic and environmental influences on insomnia, and that formally tests for sex effects.

Results: The mean scores for each sleep variable were 1.61 ± 0.91 (trouble falling asleep), 1.80 ± 0.99 (restless or disturbed sleep), 1.77 ± 1.08 (awakening in the early morning), and 5.17 ± 2.50 (composite). Correlations among the sleep items ranged from .13 to .38 for MZ females, -.03 to .16 for DZ females, .15 to .32 for MZ males, and .04 to .16 for DZ males.

Conclusion: Insomnia symptoms were most commonly endorsed at a mild to moderate severity level. Based on correlations and preliminary analysis of twin models, insomnia appears to be genetically influenced and there may be sex differences. Formal twin modeling is underway and will be completed and further discussed.

0527

THE SYNERGISTIC EFFECT OF INSOMNIA AND
HYPERAROUSAL ON INCIDENT HYPERTENSION

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Introduction: Hyperarousal is recognized as a leading contributing factor in the etiology of insomnia. Hypertension can be viewed as an indicator of physiological hyperarousal. Evidence from cross-sectional and longitudinal studies suggests that insomnia is a risk factor for hypertension. The role of hyperarousal on hypertension remains unclear, however. The present study investigated potential joint effects of insomnia and hyperarousal on incident hypertension.

Methods: Participants were 1682 adults ($M_{age} = 46$ years, $SD = 14.7$; 60.4% women) free of hypertension selected from a larger sample of an ongoing epidemiological study of insomnia. They were classified into two groups according to their sleep status at baseline: good sleeper (n = 1278) and insomnia syndrome (n = 404). Hyperarousal was operationalized by using the median score of the Ford Insomnia Response to Stress Test (FIRST) to identify individuals with high and low sleep-reactivity to stress at baseline. Incident hypertension was defined as the self-reported onset of hypertension at 3-year follow-up.

Results: Rates of incident hypertension at 3-year follow-up were 10.5% among individuals with insomnia syndrome compared to 5.2% of good sleepers. Controlling for sex, BMI, smoking, and alcohol consumption, logistic regression analyses revealed that insomnia syndrome at baseline was associated with a marginal significant risk for new onset hypertension (OR = 1.74, 95% CI 0.99-3.07). Heightened sleep-reactivity was associated with a non-significant increase risk for hypertension (OR = 1.32, 95% CI 0.77-2.26). However, the joint effect of insomnia and heightened sleep-reactivity significantly increased the risk for hypertension (OR = 2.02, 95% CI 1.03-3.93).

Conclusion: Consistent with past findings, insomnia may be a potential risk factor for new onset hypertension. More importantly, the present findings suggest that the presence of both insomnia and heightened sleep-reactivity are associated with an increased risk of new onset hypertension 3 years later.

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VULNERABILITY TO STRESS-RELATED SLEEP DISTURBANCE AND INSOMNIA: INVESTIGATING THE LINK WITH COMORBID DEPRESSIVE SYMPTOMS

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Introduction: Greater sleep difficulties following a stressful event, or vulnerability to stress-related sleep disturbance (i.e., sleep reactivity), have been demonstrated as characteristic of insomnia. However, insomnia is rarely observed in isolation, rather is frequently seen in combination with other comorbidities, such as depressive symptoms. Yet, despite the link between depression and increased sensitivity to stress, relatively little is known about the role sleep reactivity has in explaining differences in depressive symptoms among people with insomnia. Therefore, the current study examined the independent and combined association among sleep reactivity, insomnia, and depressive symptoms.

Methods: We assessed 1397 individual twins (852 female; Age = 22.5, SD = 2.72) from the Colorado Longitudinal Twin Study and Community Twin Study. Participants completed an online survey about their sleep problems and associated health outcomes. Participants were given the Ford Insomnia Response to Stress Test (FIRST), a self-report measure of sleep reactivity, and the Center for Epidemiologic Studies Depression Scale (CES-D), which assessed depressive symptomatology (sleep item removed). According to the survey data, approximately 21% (n = 292) of the sample reported symptom levels consistent with clinically significant insomnia.

Results: After controlling for age, sex, and individual sleep parameters (e.g., sleep latency), results indicated that insomnia participants reported greater depressive symptoms, $\beta = 4.065$, $t(1056) = 5.71$, $p < .001$, compared to participants without clinically significant insomnia. FIRST scores were also positively associated with depressive symptoms, $\beta = 0.280$, $t(1044) = 5.03$, $p < .001$. However, the interaction between insomnia and FIRST was not significant, $\beta = 0.152$, $t(1054) = 1.42$, $p = .16$.

Conclusion: Our results demonstrate an independent link between sleep reactivity and depressive symptomatology. Taken together, these results provide further validation of the FIRST as an assessment of a specific type of vulnerability to insomnia, a vulnerability factor that may partially explain the comorbidity between insomnia and depressive symptomatology.

Support (If Any): This study was supported by Henry Ford Hospital and NIH grant MH063207 (NPF).

0529

VARIATION IN SLEEP ONSET LATENCY TREATMENT EFFECT TRAJECTORIES FOR RAMELTEON ALONE, RAMELTEON COMBINED WITH MULTI-COMPONENT BEHAVIOR THERAPY (MCBT), AND PLACEBO ALONE IN PATIENTS WITH CHRONIC INSOMNIA

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Introduction: The present study evaluated the differential effectiveness of Multi-Component Behavior Therapy (MCBT) in combination with Ramelteon, a melatonin agonist, over control treatments on the primary sleep outcome of sleep onset latency (SOL).

Methods: Participants (n = 27, 18 females; 42.3 y, range from 18 to 61 y) with primary insomnia (SOL of > 30 minutes on > 3 nights/week and average TST > 6.5 hours) were randomly assigned to one of three groups: (a) MCBT in combination with Ramelteon, (b) Ramelteon alone,

or (c) placebo alone. Exclusion criteria included a history of insomnia treatment or shift work or travel across > 3 time zones within 6 months. A multi-level model was conducted on SOL as assessed by daily sleep diaries at baseline and over 6 treatment weeks. This method accounts for correlated residuals across time occasions while not assuming independence of observations.

Results: There was a significant interaction between group and time such that for those in the combined MCBT and Ramelteon group, time significantly predicted a decrease in the slope of SOL ($\beta = -.11$, $t(158) = -2.07$, $p < .05$). SOL decreased more rapidly over time for those in combined MCBT and Ramelteon group (M [SD] at Baseline: 51.67 [26.99] and End of treatment: 21.86 [19.91]) as compared to either placebo (M [SD] at Baseline: 50.56 [23.37] and End of treatment: 32.13 [14.54]) or Ramelteon alone (M [SD] at Baseline: 54.89 [31.01] and End of treatment: 42.47 [35.31]). For those assigned to Ramelteon alone, time showed a trend to predict SOL slope ($\beta = -.03$, $t(158) = -.50$, $p = .06$).

Conclusion: In this pilot study of individuals with chronic insomnia, the addition of multi-component behavior therapy to a melatonin agonist medication enhances treatment outcomes over both placebo and medication alone by demonstrating a more rapid reduction in time to fall asleep.

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0530

PREVALENCE AND INCIDENCE OF SLEEP COMPLAINTS IN HISPANIC VS. NON-HISPANIC ELDERS: FINDINGS FROM THE HEALTH AND RETIREMENT STUDY

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Introduction: Although there have been cohort studies restricted to the Hispanic population, few analyses have directly compared Hispanics to non-Hispanics with respect to sleep complaints within a single cohort large enough to accommodate this analysis.

Methods: Data on 16,493 (1,645 Hispanic and 14,848 non-Hispanic) elderly individuals aged 55-109 were extracted from the 2006 and 2010 waves of the Health and Retirement Study (HRS). Prevalence of sleep complaints (trouble falling asleep, waking during the night, waking up early or un-refreshing sleep) was obtained from 2006 wave. Incidence of new sleep complaints was obtained from the 2010 wave for participants (N = 3,850) with no sleep complaints in 2006 who were followed until 2010. Multivariate logistic regression was used to determine Hispanic association with presence of sleep complaints and development of new sleep complaints. Other potential predictors of incidence were inspected.

Results: In 2006 the prevalence of three or more sleep complaints was 30.9 vs. 27.3 for Hispanic and non-Hispanic respectively ($p < 0.001$). Hispanics were also more likely to develop new sleep complaints (OR = 1.60; $p < 0.001$) over the next four years. This association was unchanged after adjusting for age, sex, race and education (OR = 1.60; $p < 0.001$). Moreover, a significant Hispanic-sleep-complaint association was seen for every 10 year age group, for both males and females and by strata of race or education. Additional predictors of incident sleep complaints included having less than high school diploma, reduced self-rated health, recently becoming unemployed (other than retirement), not losing weight ($p < 0.01$ for all). Being recently retired was protective ($p < 0.05$), but was muted when adjusted for other factors.

Conclusion: Older Hispanics are more likely to develop incident sleep complaints with increasing age. These results may reflect ethnic differences in risk factors (e.g., diabetes) associated with sleep complaints, or lifestyle differences (e.g., becoming a caretaker). Understanding these factors may aid interventions to improve sleep problems.

0531

EVALUATION OF RISK FOR HYPERTENSION IN THE PATIENTS WITH INSOMNIA TAKING HYPNOTICS

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Introduction: Hypnotics are widely used in many patients with insomnia. We evaluated whether the prevalence of hypertension is greater among the patients with insomnia routinely took hypnotics than those did not.

Methods: 719 consecutive patients suffered from insomnia were selected from Sleep Medicine Center, West China Hospital from 2010 to 2013. All the patients completed an overnight polysomnography (PSG). 552 patients (42.01 ± 10.80 years old and 32.6% male) who fulfilled the criteria of apnea hypopnea index (AHI) < 5 according to the PSG recording were used in this study. Insomnia was defined by a complaint of insomnia with a duration ≥ 6 months. Hypertension was defined based either on blood pressure measures or treatment. The use of hypnotics was defined as the patients who used to take hypnotics for more than 2 months. In data analysis, we controlled for age, sex, body mass index, diabetes, smoking, alcohol use, AHI and PSG determined total sleep time.

Results: The prevalence of hypertension in female and male insomnia patients was 15.6% and 18.3%, respectively ($p > 0.05$). Among all the patients, the adjusted odds ratio (OR) for hypertension was greater in patients who took hypnotics (OR = 2.13, 95% confidence interval [CI], 1.27-3.61, $p < 0.01$) than that in those who did not (OR = 1.00). In male patients, the adjusted OR for hypertension was significantly greater in patients who took hypnotics (OR = 3.94, [1.67-9.32], $p < 0.01$) than those did not (OR = 1.00). But, in female patients, no similar results were obtained between the patients took (OR 1.63 [0.82-3.18], $p > 0.05$) or did not take hypnotics (OR = 1.00).

Conclusion: The results suggest that often taking hypnotics in patients with chronic insomnia may be associated with increased risk of hypertension, especially in male patients.

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0532

EFFECTIVENESS OF A CBT INTERVENTION FOR PERSISTENT INSOMNIA AND HYPNOTIC DEPENDENCY IN AN OUTPATIENT PSYCHIATRY CLINIC

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Introduction: Previous research supports the efficacy of cognitive-behavioral therapy for insomnia (CBT-I) in patients with comorbid psychiatric diagnoses; however, questions remain about its effectiveness due to the fact that previous studies excluded patients with significant psychiatric symptoms or certain comorbid diagnoses. This study tested five sessions of CBT-I in patients receiving mental health treatment in an outpatient psychiatry clinic who continue to experience chronic insomnia despite receiving pharmacological treatment for sleep.

Methods: Participants (N = 23) were randomized to CBT-I (n = 13) or treatment-as-usual (n = 10). Those in the CBT-I group completed five sessions of individual treatment. Those in the treatment-as-usual group continued with medication treatment as prescribed by their psychiatrist for five weeks and were then given the opportunity to receive CBT-I. All participants completed questionnaires and one-week sleep diary at pre- and post-treatment. Repeated-measures ANOVA was used to assess group differences from pre- to post-treatment in global insomnia sever-

ity (ISI score), sleep efficiency (SE), total sleep time (TST), sleep onset latency (SOL), depression (PHQ-9), and anxiety (GAD-7).

Results: There was a significant time-by-group interaction for SE (Pillai's Trace = .337, $F[1, 17] = 8.64$, $p < .01$ and marginally significant time-by-group interactions for ISI (Pillai's Trace = .207, $F[1, 17] = 4.43$, $p = .050$), TST (Pillai's Trace = .173, $F[1, 17] = 3.64$, $p = .076$), and SOL (Pillai's Trace = .152, $F[1, 17] = 3.04$, $p = .099$). Sleep gains were largely maintained at two-month follow-up. No significant changes in depression or anxiety severity were seen in the CBT-I group, suggesting sleep interventions alone may not have the same impact in a psychiatric sample with more severe and chronic psychiatric symptoms. CBT-I was not associated with a reduction in use of sleep medication. This may reflect this sample's high level of chronicity of insomnia or a propensity towards medication dependency.

Conclusion: Findings suggest that patients with complex and chronic psychiatric conditions can obtain sleep improvements with CBT-I beyond those obtained with pharmacotherapy alone.

0533

ATTACHMENT AVOIDANCE, ANXIOUSNESS, AND SLEEP PROBLEMS AMONG RECENTLY DIVORCED ADULTS

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Introduction: Divorce is a stressful life event which may impact attachment style and sleep in adults. This study examines the relationship between attachment characteristics and sleep disturbances following divorce. Previous attachment research suggests sleep disruption may be increased with anxiety and decreased with avoidance.

Methods: 87 individuals who physically separated from their ex-partner in the past 5 months (65.5% Caucasian, mean age 44.3 ± 10.8 years) completed baseline measures of the Experiences in Close Relationships Scale (ECRS), Pittsburgh Sleep Quality Index (PSQI), and Center for Epidemiological Studies Depression Scale (CES-D); actigraphy was also used for 7 days to obtain a concurrent measure of sleep.

Results: Higher avoidance in relationships predicted increased SOL ($\beta = .23$, $p < .05$), decreased sleep quality ($\beta = .20$, $p < .05$), and poorer overall sleep ($\beta = .18$, $p < .05$) above the effects of age, sex, separation length, sleep medication use, and depression. Anxiousness in relationships was not a significant predictor. Individual were classified into 4 groups based on high/low avoidance and high/low anxiety. Planned contrasts showed that highly avoidant people reported significantly more sleep problems compared to individuals with low avoidance. Among highly avoidant individuals, those reporting higher anxiety had more sleep problems than those with lower anxiety.

Conclusion: Contrary to hypotheses, higher avoidance (not anxiety) was predictive of poor sleep outcomes. Planned contrasts corroborated regression findings; avoidance was related to more sleep difficulties than anxiousness. Among groups with high avoidance, those with higher anxiety reported more sleep problems than those with lower anxiety, suggesting that anxiety is most detrimental to sleep when it is at higher levels and paired with highly avoidant tendencies.

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0534

PATIENT-REPORTED ADHERENCE TO STIMULUS CONTROL INSTRUCTION IS ASSOCIATED WITH OUTCOME FOLLOWING GROUP COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA

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Introduction: Cognitive behavioral therapy for insomnia (CBTI) is an effective multi-component treatment for insomnia. To our knowledge, the relationship between treatment outcome and patient's perceptions of their own adherence to and difficulty following treatment recommendations, and the extent to which the recommendations were perceived as helpful have not received much attention.

Methods: 127 individuals referred by a sleep physician to group CBTI and meeting Quantitative Criteria for insomnia (QC) completed a 7-session CBTI group treatment (age 49.2 ± 14.0 y, 44% men). QC was defined as having > 30 minutes sleep onset latency or wake after sleep onset at least three nights a week based on prospective sleep diary reports. Post-treatment, participants rated the extent to which they followed specific treatment recommendations, the difficulty they had following each, and how helpful each component was using Likert rating scales.

Results: Compared to participants who still met QC criteria at post-treatment, remitters (those who no longer met QC criteria; 30%) reported greater adherence to "getting out of bed when I cannot sleep" (a stimulus control instruction; $t = 2.45$, $p = .016$). However, they did not perceive this treatment component to be more helpful or difficult to follow (p -values $> .05$). While reported adherence to other treatment components did not differ, remitters reported less difficulty following the recommendation to "reserve bed and bedroom only for sleep" ($t = -2.46$, $p = .015$). They also reported as more helpful recommendations to find pleasurable activities to engage in when up and out of bed ($t = 3.50$, $p = .001$).

Conclusion: The results suggest that CBTI therapists may want to spend additional time helping patients find pleasurable ways to spend their time when up and out of bed when unable to sleep in order to improve adherence to this key stimulus control instruction.

0535

THE NATURAL HISTORY OF INSOMNIA: CAN WE PREDICT WHO TRANSITS FROM ACUTE TO CHRONIC INSOMNIA?

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Introduction: Despite a significant research agenda on insomnia, spanning over 40 years, there is little data regarding how acute insomnia becomes a chronic disorder. The aim of the present study was to determine the role of self-reported psychological factors (personality, stress, coping, and sleep-related cognitions and consequences) on the transition from acute to chronic insomnia.

Methods: A longitudinal survey with a short follow-up was conducted on subjects that transitioned from either acute to chronic insomnia or from acute insomnia to recovery (good sleep). Psychologic factors were assessed for between group differences. Variables that differentiated between the groups were further evaluated using logistic regression.

Results: Of those with acute insomnia at baseline ($n = 89$), 55 (61.8%) recovered and 34 (38.2%) met full criteria for Insomnia Disorder (ID) at

three months. The between group analysis revealed that the ID subjects 1) did not significantly differ with respect to age, sex, cohabitation status, ethnicity, or educational attainment and 2) exhibited lower openness to experience, higher substance use and self-blame as coping strategies, higher fatigue and depression scores, and higher scores on the affective consequences dimension of the sleep preoccupation scale. The full model was statistically significant ($X^2(6) = 42.29$, $p < .001$) explaining between 37.8% and 51.4% of the variance in transition status and the model correctly classified 84.3% of the cases. Only three factors significantly predicted group status: the affective consequences dimension of the sleep preoccupation scale, perceived fatigue levels, and the use of substances as a coping mechanism.

Conclusion: The present results suggest that the transition from acute insomnia to chronic insomnia is not presaged by stress (life events, perceived stress, or daily hassles) but rather the affective and behavioural responses to the initial period of insomnia. The findings broadly reflect Spielman's model of insomnia and are considered with respect to a preventative intervention agenda.

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0536

ANALYSIS OF SLEEP ARCHITECTURE IN PATIENTS WITH CHRONIC INSOMNIA VS. OSA PLUS INSOMNIA WHILE ON PAP

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Introduction: Studies suggest patients with OSA and co-morbid chronic insomnia have an increased likelihood of failing CPAP therapy. This study evaluates the sleep architecture in this patient population as compared to those with chronic insomnia.

Methods: Twenty-one patients completed the Epworth Sleepiness Score (ESS), Insomnia Severity Index and Patient Health Questionnaire (PHQ-9) prior to completing a two-night in-home assessment of sleep architecture (Sleep Profiler™, Advanced Brain Monitoring, Carlsbad, CA). Sleep diaries were completed after each night's study. This retrospective analysis included 13 patients with chronic insomnia (52 ± 17.1 years), and eight patients diagnosed with OSA plus chronic insomnia, and being treated with positive airway pressure (PAP)(63 ± 9.1 years). Manual editing of the automated sleep staging was conducted by staff at each study site.

Results: Patients with OSA+I+PAP showed increased cortical arousals (17.0 ± 9.0 vs. 10.2 ± 5.4 /hour; $p < 0.01$), and less percent of sleep time REM (13.9 ± 5.3 vs. $20.1 \pm 7.0\%$; $p < 0.01$), as compared to patients with chronic insomnia, based on Bonferroni-corrected t-tests. The OSA+I+PAP patients also exhibited significantly greater daytime sleepiness (ESS: 10.5 ± 5.2 vs. 3.9 ± 1.9 ; $p < 0.0001$), and increased depression (PHQ9: 15.3 ± 7.4 vs. 7.6 ± 4.2 ; $p < 0.0001$). There were no within or across group night-to-night differences in objectively or subjectively measured sleep quality, including recording and sleep time, sleep efficiency, sleep latency or wake-after-sleep-onset and awakenings.

Conclusions: In this preliminary study we found that patients with chronic insomnia and co-morbid OSA, when treated with CPAP, do not sleep better, in fact sleep significantly worse, than patients with chronic insomnia but without OSA. It suggests that, at least in a sub-set of chronic insomnia patients with coexisting OSA, the chronic insomnia may be unrelated to the OSA. PAP treatment could increase the insomnia markers, and increase the likelihood of discontinuing PAP use.

0537

FIRST NIGHT EFFECT IN OBJECTIVE AND SUBJECTIVE EVALUATED SLEEP IN PATIENTS WITH PRIMARY INSOMNIALi Z¹, Huang L², Zhou J^{1,3}, Zhou G¹, Tang X¹¹Sleep Medicine Center, West China Hospital, Sichuan University, Chengdu, China, ²Heilongjiang University of Chinese Medicine, Harbin, Heilongjiang, China, ³Department of Neurology, West China Hospital, Sichuan University, Chengdu, China

Introduction: Underestimated self-evaluated subjective sleep amount is the central issue in the patients with primary insomnia. For the first night effects (FNE), the previous studies mainly focused on the differences in sleep architectures between first and second nights in insomnia. We examined FNE on both subjective and objective sleep in insomnia through the current multicenter study.

Methods: We collected data in 125 patients with primary insomnia (51.4 ± 10.4 years old, 38 males) according to the diagnostic criteria in DSM-IV at five hospitals. Patients underwent two consecutive nights of polysomnography (PSG), and subjective sleep was evaluated via a morning questionnaire following overnight PSG recording. Sleep perception was calculated as subjective sleep time/objective sleep time*100%.

Results: For sleep architecture in the second night compared to the first night, the patients had increases in total sleep time and N3 time, and decreases in N1 time, rapid eye movement (REM) time, time of wakefulness after sleep onset, sleep latency, latency to REM ($p < 0.05$). For subjective sleep evaluation, in the second night compared to the first night, an increase was obtained in total sleep time (185 ± 116 vs. 229 ± 109 min, $p < 0.001$), but no changes in sleep latency, number and time of wakefulness after sleep onset. A trend of increase in sleep perception was seen in the second night compared to first night (60 ± 48% vs. 67 ± 33%), but it did not reach at significant level ($p = 0.107$).

Conclusion: Through this multicenter study, we found that the significant FNE can be seen in both objectively and subjectively evaluated sleep in the patients with primary insomnia. The patients with primary insomnia appear to perceive better sleep in the second night than in the first night in overnight sleep study.

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NIGHT TO NIGHT VARIABILITY IN SLEEP QUALITY METRICS IN PATIENTS WITH CHRONIC INSOMNIALevendowski DJ¹, Westbrook PR¹, Cetel M², Rosenberg RS³, Hirst M³, Matic Z¹, Cifelli A¹¹Advanced Brain Monitoring, Inc., Carlsbad, CA, USA, ²Integrative Insomnia and Sleep Health Center, San Diego, CA, USA, ³Sleep Disorders Center of Prescott Valley, Prescott Valley, AZ, USA

Introduction: Responses from a sleep diary are relied up in the diagnosis and treatment of chronic insomnia. This study assesses night-to-night variability in, and the association between, subjective and objectively-recorded sleep patterns.

Methods: Twenty patients with chronic insomnia completed a sleep diary each morning after completing a two-night, in-home study with Sleep Profiler™ (Advanced Brain Monitoring, Carlsbad, CA). This cohort included ten patients with comorbid OSA; eight were studied in-home while on CPAP. Sleep diary responses provided measures of lights out to lights on, sleep-time, sleep-efficiency, sleep-onset, and wake-after-sleep-onset (WASO). The associated objective measures were derived from manual editing of software enabled automated sleep staging. Pearson correlations and Bland-Altman plots were used to assess within- and across-night associations among the sleep measures.

Results: There was moderate between-night agreement in objective sleep-time ($r = 0.56$; $p < 0.01$). The concordance between the objective and subjective sleep-time improved on night-two ($r = 0.81$; $p < 0.00001$), as compared to night-one ($r = 0.46$; $p > 0.05$). There was substantially less night-to-night variability in objective sleep-efficiency ($r = 0.82$; $p < 0.00001$), as compared to self-reported sleep-efficiency ($r = 0.48$; $p < 0.05$). The night-to-night agreement in sleep-onset was stronger when detected electro-physiologically ($r = 0.74$; $p < 0.001$), as compared to the self-report ($r = 0.47$; $p < 0.05$). The agreement between objective and subjective reports of sleep-onset were stronger on night-two ($r = 0.84$; $p < 0.00001$) vs. night-one. ($r = 0.50$; $p < 0.05$). Strong night-to-night consistency was observed for both objective WASO ($r = 0.68$; $p < .001$) and subjective WASO ($r = 0.73$; $p < 0.001$). There was no relationship between objective and subjective WASO for nights-one or night-two. Both objective and subjective measures of SE and SO were bias toward improved sleep quality on night 2.

Conclusions: Objective measures of sleep-time, sleep efficiency, and sleep-onset report less night-to-night variability as compared to sleep diaries. A first-night effect was evidenced by patients' improved accuracy in estimating sleep-time and sleep-onset on night-two, with concurrent improved objective sleep efficiency and reduced sleep onset on night-two.

0539

SLEEP IMPROVEMENT IN AN AREA DEVASTATED BY THE GREAT EAST JAPAN EARTHQUAKE: EFFECTS OF SLEEP HYGIENE EDUCATION AND RELAXATION TRAINING ON SLEEP DIFFICULTIESSato T¹, Ambo H², Fukuda K³¹Department of Health and Social Services, Tohoku Bunka Gakuen University, Sendai, Japan, ²Department of Clinical Psychology, Tohoku University, Sendai, Japan, ³Department of Psychology and Humanities, Edogawa University, Nagareyama, Japan

Introduction: Increases in incidences of sleep difficulties have already been reported in the wake of natural disasters, and this was also the case among survivors of the Great East Japan Earthquake in a coastal residential area of Sendai City, capital of Miyagi Prefecture. Miyagi Prefecture, located on the northeastern Pacific coast of Honshu, was 130 km from the epicenter of the undersea earthquake that triggered a massive tsunami along the main Japanese island's eastern Pacific coast. Both the earthquake and tsunami caused great damage to Miyagi Prefecture's coastal area. As part of efforts to address mental health problems following the earthquake, we conducted health educational programs in several cities there, including five half-day programs in Sendai and one each in Ishinomaki, Shiogama, Iwanuma, and Kesen-numa. A lecture on sleep hygiene was presented during the programs, which also included opportunities to practice relaxation techniques. To determine the sleep improvement effects of our programs, we carried out a follow-up questionnaire survey one month after attending our programs.

Methods: We mailed a follow-up questionnaire survey to program attendees who had given us their informed consent. The questionnaire contained two sets of items from the Pittsburgh Sleep Quality Index (PSQI): one regarding their sleep conditions during the month prior to attending our half-day programs, and the other for a similar period of time after attending. Of these, 22 (14 females, 8 males) completed and returned the surveys. Respondents ranged in age from 26 to 81 years, with an average age of 54 years (SD: 16.56). We used a one-factor repeated-measure ANOVA to compare their scores on the PSQI.

Results: Results revealed that these were significantly decreased after attending our health educational programs ($p < 0.001$). In addition, the number of participants whose total score on the PSQI was six or more was decreased from 19 to 15.

Conclusion: In conclusion, these results suggest that our health education programs for improving sleep would be somewhat useful for alleviating sleep difficulties among residents of areas devastated by natural disasters.

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SLEEP QUALITY DUE TO CO-SLEEPING WITH PETS

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Introduction: Studies of co-sleeping or sharing the bed have been performed previously but typically have only evaluated the effects of sharing the bed with a spouse or children. The impact of co-sleeping with pets on sleep quality has not been a focus of these studies. Our hypothesis is co-sleeping with pets may lead to sleep fragmentation or have other adverse consequences on sleep quality.

Methods: We sampled 300 subjects of a family practice clinic in an urban, academic setting. They completed a questionnaire containing 17 questions with multi-answer alternatives regarding co-sleeping with pets, number of pets sleeping in the bed, sharing bed number of times per week, pet snoring, difficulty falling back to sleep once awake, difficulty falling back to sleep once out of bed and Pittsburgh Sleep Quality Index. The subjects were divided into those sleeping with pets and without pets. Two subjects' data were not included due to incomplete questionnaires. The remaining 298 questionnaire responses were included in the analysis. Spearman correlation coefficients were used to compare the variables.

Results: There was no significant difference in the mean age and gender distribution between the groups. Of the 148 subjects that slept with pets, no significant difference in the mean age or gender was noted. The types of pets owned by the subjects were cats (42%) and dogs (58%). 80/148 (54%) of subjects had pets either in their bed or in the bedroom. 77 (52%) actually shared the bed with the pet. Of those subjects sleeping with their pet, 56 (63%) reported sleeping more than 4 nights per week with the pet and had poor sleep quality ($P = 0.03$). 8/148 (5%) reported almost always or always having trouble re-initiating sleep after being awakened by the pet and had poor sleep quality ($P = 0.0006$). 8/148 (5%) reported difficulty falling back to sleep after getting out of bed due to the pet and had poor sleep quality ($P = 0.0003$).

Conclusion: Nearly one-third of pet owners in our survey report being awakened at least once per night due to their pet. Of those sharing bed with pet more than 4 nights per week (63%) had poor sleep quality. Five percent reported difficulty in sleep maintenance related to their pet. Inquiry about pet ownership during an insomnia history may add insight into factors contributing to insomnia.

0541

SLEEP INITIATION COMPLAINTS ARE ASSOCIATED WITH LOWER CARDIORESPIRATORY FITNESS AMONG SEDENTARY POSTMENOPAUSAL WOMEN

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Introduction: Cardiorespiratory fitness (CRF) is a strong independent predictor of cardiovascular risk and is influenced by habitual physical

activity as well as genetic factors. Although poor sleep is associated with low levels of physical activity, little is known about the relationship between sleep quality and CRF. The purpose of this study was to examine the relationship between sleep quality and cardiorespiratory fitness in a sample of sedentary postmenopausal women.

Methods: 390 overweight and sedentary postmenopausal women (age: 57.3 ± 6.4 yr, body mass index [BMI]: 31.7 ± 3.8) participated in this study. Sleep was assessed with 6 items from the Medical Outcomes Study Sleep Scale, with 2 questions each focused on difficulties with sleep initiation, sleep maintenance, and daytime sleepiness. A composite Sleep Problems Index assessed global sleep quality. CRF was assessed with a maximal exercise test on a cycle ergometer; peak relative maximal oxygen consumption (VO_{2peak}) served as the primary CRF measure. Only tests with objective determination of maximal exertion (maximal respiratory exchange ratio ≥ 1.05) were included in analyses. All analyses adjusted for age, race/ethnicity, BMI, marital status, pedometer-assessed physical activity, and sleep medication use.

Results: Global sleep quality was not associated with CRF ($\beta = -.08$, $P = .09$). However, greater sleep initiation complaints were significantly associated with low CRF ($\beta = -.12$, $P = .008$). Specifically, women who reported a sleep latency > 30 min and difficulty falling asleep "most/all of the time" had significantly lower CRF than all other women (14.4 ± 0.5 ml/kg/min [$n = 48$] vs. 15.4 ± 0.5 ml/kg/min [$n = 342$], $P = .01$). In contrast, neither sleep maintenance complaints nor daytime sleepiness were associated with CRF ($\beta = -.05$, $P = .31$ and $\beta = .00$, $P = .92$, respectively).

Conclusion: Self-reported difficulty initiating sleep correlates with low cardiorespiratory fitness. Because of the robust relationship between CRF and cardiovascular health, CRF may be a mechanism that partially explains the relationship between poor sleep and cardiovascular risk.

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0542

EXAMINATION OF SLEEP CONTINUITY AND INSOMNIA SEVERITY IN PERI AND POSTPARTUM WOMEN WHO PERCEIVE THEIR SLEEP TO HAVE WORSENE BY THE MENOPAUSAL TRANSITION

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Introduction: Sleep disturbance is a key symptom of the menopause transition. It remains unclear whether the perception of sleep worsening during the menopause transition is related to insomnia symptoms or severity. This cross-sectional study tests the hypothesis that in peri and postmenopausal women who are reporting worsening of sleep during the menopause transition have more severe insomnia symptoms than women who do not perceive worsening of sleep during the menopause transition.

Methods: 292 women, perimenopausal (59%, age 38-58 years, $m = 49.5 \pm 3.9$) or postmenopausal (41%, age 38-75 years, $m = 54.8 \pm 5.0$), due to natural causes, completed an online survey about sleep (SOL, WASO, TST, TIB and the Insomnia Severity Index (ISI)). Participants rated the extent to which their sleep worsened during the menopause transition (WORSE) on a 4-point Likert scale. Responses were dichotomized (none/a little vs. quite a bit/extremely).

Results: A 2×2 MANCOVA (using all sleep variables as dependent variables), with menopausal status (peri vs. postmenopause) and WORSE (yes vs. no), controlling for age and years past menopause (coding perimenopause as 0 years), revealed a significant main effect for WORSE ($p < .001$). Peri and postmenopausal women who reported their sleep worsened with the menopause transition reported significantly

lower TST (5.6 h vs. 6.6 h) and SE (100*TST/TIB; 72% vs. 87%); and higher SOL (33 min vs. 24 min), WASO (70 min vs. 39 min) and ISI scores (15 vs. 9). The main effect for menopausal status and the interaction effect were not significant (p -values $> .3$).

Conclusion: Women who perceive their sleep to worsen during the menopause transition report more severe insomnia symptoms regardless of number of years past menopause and menopausal status. The results are consistent with the Spielman etiological model of insomnia but longitudinal data are needed to determine if and what aspects of the menopause transition precipitate insomnia in this age group and what individual characteristics predict continued problems sleeping.

Support (If Any): T32MH019938; K23NR014008.

0543

EXAMINATION OF THE EFFECT OF YEARS SINCE MENOPAUSAL ONSET ON SLEEP DISTURBANCE AND NOCTURNAL HOT FLASHES IN POSTMENOPAUSAL WOMEN

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Introduction: Sleep disturbance is a prevalent symptom of the menopause transition that is often associated with vasomotor symptoms. Vasomotor symptoms typically abate 4-6 years after menopausal onset, while sleep disturbance may continue to be problematic well beyond the remission of vasomotor symptoms. The study aimed to test the hypothesis that the number of years following menopausal onset will predict the occurrence of nocturnal hot flashes but not insomnia severity or sleep disruptions among postmenopausal women.

Methods: One hundred seventy nine women, self-described as postmenopausal (age range 34-75, $m = 54.5 \pm 5.5$), completed an online survey about sleep and menopause, which included questions on current age, age of menopause onset, menopause etiology (i.e., natural, surgical, chemo/radiation, other), experiencing nocturnal hot flashes in the past two weeks, average minutes wake after sleep onset (WASO) per night, and Insomnia Severity Index (ISI).

Results: After controlling for menopause etiology, a multiple linear regression model revealed that years since menopausal onset significantly predicted the occurrence of nocturnal hot flashes ($\beta = -.165$, $p = .020$), but did not significantly predict insomnia symptom severity ($\beta = -.136$, $p = .063$) or WASO minutes ($\beta = -.100$, $p = .183$). Secondary analyses revealed that years following menopausal onset did not significantly predict difficulty falling asleep ($\beta = -.029$, $p = .690$) or difficulty staying asleep ($\beta = -.012$, $p = .869$); however, it did significantly predict difficulty waking up too early ($\beta = -.160$, $p = .028$).

Conclusion: This study suggests that for postmenopausal women, nocturnal hot flashes diminish with years since menopausal onset. Self-reported sleep disruptions and insomnia severity, however, are independent of years since menopausal onset. This cross-sectional study is consistent with, but does not prove, the behavioral conditioning theory for perpetuating insomnia in postmenopause originally proposed by Krystal and colleagues. The possibility that early treatment of sleep disruptions among women whose sleep worsened by the transition to menopause may prevent future development or persistence of insomnia is intriguing and merits future investigation.

0544

PATIENTS' EXPERIENCES AND PERCEPTIONS OF A NOVEL MODEL FOR DELIVERING COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA

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Introduction: Cognitive behavioral therapy for insomnia (CBTI) is an effective treatment for insomnia when delivered by behavioral sleep medicine (BSM) psychologists. In a randomized control trial (RCT), we demonstrated that CBTI was equally successful in improving sleep for up to one year in both individual and group formats when delivered by master's level trained health educators under the supervision of a BSM psychologist at a VA medical center. At the conclusion of the study, we sought input from participants to identify potential patient-level facilitators and barriers to dissemination of this model of CBTI delivery.

Methods: Focus groups (FGs) were conducted among RCT participants who completed 5 sessions of CBTI. We explored participants' experiences with CBTI, their perceptions of the instructor and content, and preferences for program format and type of provider. Note-based analysis of transcripts was performed to identify themes and domains using standard qualitative methodology.

Results: Four FGs were sufficient to reach data saturation with 35 participants (mean age 72 years; 89% male) who were, on average, 26.7 months post-CBTI. FG participants did not differ from nonparticipants ($n = 71$) at baseline or at follow-ups. Consensus emerged that: 1) Master's level trained health educators were legitimate and credible CBTI providers; 2) CBTI was acceptable and personally helpful whether delivered in individual or group format; 3) CBTI should be available outside of a mental health clinic setting (eg, primary care, sleep center); 4) Screening for insomnia should occur in primary care; and 5) Patients should be able to self-refer for CBTI.

Conclusion: Older veterans enthusiastically support CBTI treatment delivered by master's level health educators that is accessible outside of mental health. These findings suggest that access to CBTI could be augmented beyond the existing delivery models by using health educators supervised by BSM psychologists.

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0545

A PHASE I STUDY IN HEALTHY SUBJECTS OF THE SAFETY AND TOLERABILITY OF E2006, A NOVEL DUAL OREXIN RECEPTOR ANTAGONIST FOR THE TREATMENT OF INSOMNIA DISORDER

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Introduction: E2006 is a dual orexin receptor antagonist (DORA) being developed for the treatment of insomnia. Here we report results of safety, tolerability, and pharmacodynamics of single doses of E2006 in a single ascending dose study in healthy subjects.

Methods: Subject cohorts ($n = 8$) were randomized into the study; each subject received a morning dose of E2006 ($n = 6$) or placebo ($n = 2$). Subjects remained in the clinic for 6 days for evaluations of safety and tolerability. Sleepiness, assessed by the Karolinska Sleepiness Scale (KSS) and Psychomotor Vigilance Test (PVT), was evaluated predose, every 2 h through 12 hours postdose, and upon morning awakening each day. Decisions to proceed to a higher dose and whether a maximum tol-

erated dose (MTD) had been achieved were made after blinded reviews of safety data from each cohort.

Results: Eight cohorts (n = 64) completed the study, with E2006 doses of 1, 2.5, 5, 10, 25, 50, 100, and 200 mg. Dose escalation was discontinued without reaching a MTD, but after achieving a sufficiently high tolerated dose to provide adequate safety margins relative to anticipated therapeutic doses. There were no serious AEs, nor any clinically relevant ECG, vital sign, or dose-related laboratory findings. The most common AE was headache, occurring in approximately 10% of both E2006 and placebo subjects. Sleep paralysis was reported in 4 subjects (2 at 50 mg; 2 at 200 mg of E2006). The magnitude and duration of sleepiness was dose-related and generally maximal at 2 h postdose. No clinically relevant differences from placebo were observed beyond 8 h postdose up to 25 mg, while at 100 mg and 200 mg of E2006, KSS and PVT scores were higher than placebo through 12 hours postdose.

Conclusion: In this study E2006 was well tolerated in healthy subjects at single doses up to 200 mg. Additional research is warranted to evaluate the safety and efficacy of E2006 for insomnia disorder.

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0546

EXPLORING SLEEP MEDICATION TAKING BELIEFS AND BEHAVIORS IN PATIENTS WITH INSOMNIA

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Introduction: Pharmacological sleeping aids are often used in the management of insomnia. The standard advice given to the patient who is prescribed one of these medications is to not use them regularly but only 'when required'. However, little is known about how patients interpret this instruction or whether such an approach is useful for promoting the quality use of hypnotics. Therefore, the purpose of the current study was to explore patients' beliefs and behavioral practices regarding their medication taking for insomnia.

Methods: In-depth semi-structured interviews were conducted with insomnia patients recruited from primary care and/or tertiary sleep/psychology clinics. Interviews were guided by a schedule of topics which focused on insomnia treatments and experiences, were transcribed verbatim and analyzed using Framework Analysis for emerging themes.

Results: This ongoing study consists of seven analyzed interviews. Participants had a longstanding history of medication use but stated they disliked taking medications whilst desiring to achieve "a natural sleep". Even when participants experienced difficulty sleeping, they tended to delay medication in favor of passive sleep-promoting strategies. This delaying strategy had been time consuming and induced increasing levels of "frustration" and "desperation" for the participant before acknowledging the need to take medication. A subset of participants also intentionally reduced prescribed dosages of their own accord and regarded this as a positive behavior.

Conclusion: This is a first qualitative study exploring patients' medication taking practices for insomnia. Participants' current behaviors go against therapeutic recommendations and may be a reflection of their uncertainties towards medication taking. Refining public health messages to explain the role of pharmacotherapy for insomnia and the importance of the timing of medication administration appears to be a key step for driving the quality use of hypnotic medications.

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0547

IS SLEEP CONTINUITY DISTURBANCE A RISK FACTOR FOR INFERTILITY?

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Introduction: While sleep continuity disturbance (insomnia) is a known risk factor for medical and mental health problems, to date no work has been undertaken on the specific association between insomnia and reproductive health. Accordingly, the focus of the present investigation was to evaluate, in a preliminary way, whether sleep continuity disturbance is a risk factor for infertility.

Methods: A pilot investigation was undertaken at the University of Pennsylvania's fertility practice that involved patients' completion of an online questionnaire in concert with a systematic review of each patient's electronic medical record data. Each individual (n = 57) completed a survey comprised of instruments to assess sleep; mood; stress; reproductive history; and demographics. The present analysis utilized the Insomnia Severity Index (ISI) in women seeking fertility care to evaluate whether insomnia is associated with pregnancy history.

Results: Twenty-five per cent of women seeking infertility care reported clinically significant insomnia symptoms (ISI > 7). Women without elevated insomnia symptoms reported more prior pregnancies (M = 2.17; SD = .94) than women with elevated insomnia symptoms (M = .57; SD = .54) ($p < .01$). The number of pregnancies and insomnia severity did not vary by age or BMI.

Conclusion: Women seeking fertility care appear to experience insomnia at higher rates than population norms (i.e., Ohayon's estimate that 8-18% of the population report dissatisfaction with sleep quality or quantity) and that insomnia in this group may be associated with reduced fecundity. If subsequent analyses and studies bear out this association, this may suggest that infertility care may be more successful given concomitant treatment for insomnia.

0548

COMPARISON OF OBJECTIVE AND SUBJECTIVE MEASURES OF AWAKENINGS IN PATIENTS WITH CHRONIC INSOMNIA

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Introduction: This study evaluates the relationship between self-reported awakenings and a range of objectively-derived awakening durations.

Methods: Twenty-three patients with chronic insomnia were studied for two-night in-home (Sleep Profiler™, Advanced Brain Monitoring, Carlsbad, CA). From Site-One, nine subjects were studied prior to cognitive behavioral therapy insomnia (CBT-I); two subjects also completed a post-CBT-I study. Of the 14 subjects from Site-Two, ten had comorbid OSA, and eight were studied while on CPAP. The automated sleep staging was manually edited by staff at each study site. In addition to the 30-second awakening based AASM criteria, awakenings were tallied based on consecutive wake epochs from 60-sec to 300-seconds. Sympathetic arousals were based on a six beat-per-minute pulse rate increase compared to the previous 10th beat. From sleep diary responses acquired each night, studies were stratified into Low-number (< 4 awakenings/night) and High-number awakenings groups.

Results: No between-group differences were observed in objectively measured awakenings/hour using any of the objectively-measured

awakening durations. There was no association between the self-reported number of awakenings/night vs. any of the objectively-measured awakening durations. Bonferroni-corrected t-test revealed the High-number of self-reported awakening group ($n = 14$ nights) had significantly greater number of sympathetic arousals per hour (33.7 ± 19.7 vs. 13.2 ± 9.1 ; $p < 0.0001$) as compared to the Low-number group ($n = 31$ nights). For the Low-number awakening group, the bias toward patient under-reporting awakenings was decreased from an average difference of 12-per-night with a 30-second awakening duration, to two-per-night with a 300-second awakening duration. For the High-number awakenings group, the average difference decreased from 8-per-night for a 30-second duration, to zero for a 210-second awakening duration.

Conclusion: Patients with chronic insomnia do not accurately estimate awakenings as defined by standard 30-second durations. Longer duration awakenings more closely match subjective experience. Increased heart rate variability during sleep appears more prevalent in patients who self-report greater numbers of awakenings/night.

0549

NIGHT TO NIGHT VARIABILITY IN SLEEP ARCHITECTURE AND CONTINUITY IN PATIENTS WITH CHRONIC INSOMNIA

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Introduction: This study investigates night-to-night variability in sleep architecture and sleep continuity in patients with chronic insomnia.

Methods: Twenty-two patients with chronic insomnia completed a two-night, in-home study with Sleep Profiler (Advanced Brain Monitoring, Carlsbad, CA) prior to CBT-I. This cohort included ten patients with comorbid OSA; eight were studied in-home while on CPAP. The automated sleep staging were manually edited by sleep center staff, prior to computing the percent time by stage. Awakenings were based on a minimum 30-second duration as well as a 90-second duration of wake intrusion/hour. Pearson correlations and Bland-Altman plots were used to assess night-to-night agreement. Automated detection of cortical arousals were based on a 3-second increase in median alpha to sigma power-spectra. Sympathetic arousals were based on a six beat-per-minute pulse rate increase compared to the previous 10th beat. Movement arousals exceeded a threshold magnitude of actigraphy change. Snoring arousals were based on a sudden substantial decrease in amplitude after a period of loud snoring. Arousal indexes were derived per hour of sleep.

Results: Strong night-to-night concordance was observed for stages N1 ($r = 0.84$; $p < 0.00001$) and N3 ($r = 0.72$; $p < 0.0001$), and reasonable agreement for stage N2 ($r = 0.56$; $p < 0.01$). Substantial variability in the percent-time REM was attributed to the bias toward increased percent-time N1 and N3, and decreased REM, on Night 2 (bias = 0.8%, 1.4% and -2.1%, respectively). Repeated-measure variability in the awakening index was reduced when the awakening duration was increased from 30- to 90-seconds ($r = 0.66$; $p < 0.001$, and $r = 0.77$; $p < 0.00001$, respectively). Strong night-to-night agreement in the cortical arousal index ($r = 0.84$; $p < 0.000001$), sympathetic arousal index ($r = 0.93$; $p < 0.000001$), movement arousal index ($r = 0.75$; $p < 0.0001$) and snoring arousal index ($r = 0.75$; $p < 0.0001$) suggest fairly stable measures of sleep continuity.

Conclusion: These preliminary results suggest sleep architecture and sleep continuity may be useful in defining sleep trait characteristics.

0550

PRELIMINARY EVIDENCE FOR THE EFFICACY OF ACCEPTANCE AND COMMITMENT THERAPY IN PRIMARY INSOMNIA

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Introduction: In primary insomnia (PI), a discrepancy between severe subjective symptoms and minor objective disruptions of sleep has been described. Current state-of-the-art treatments, cognitive behavior therapy (CBT-I) and hypnotic medication, have been shown to acutely improve sleep, however, an impaired Quality of Life (QoL) often persists after treatment. We posit that Acceptance and Commitment Therapy (ACT) improves the QoL through the enhancement of psychological flexibility. This study hypothesizes that sleep and QoL are partially independent and evaluates the impact of ACT on QoL and sleep quality in individuals with PI.

Methods: Eleven individuals with PI according to DSM-IV criteria who were non- or partial responders to CBT-I were included. They participated in six weekly ACT sessions in an outpatient group setting. Primary outcomes were QoL, as measured by the Glasgow Sleep Impact Index (sleep-related QoL) and the World Health Organization Quality of Life scale (global QoL), and subjective sleep quality, as measured by sleep diaries. Secondary outcomes were subjective sleep data as measured by sleep diaries. Data were collected 6 weeks (T-1) and directly (T0) before the intervention, directly after the intervention (T1) and at three-months-follow-up (T2).

Results: Ten subjects completed the study, one dropped out due to scheduling problems. All outcomes remained stable between T-1 and T0. Significant improvements after the intervention were observed for the sleep-related QoL and global QoL (ANOVA with factor Time, post-hoc contrasts T1 and T2 vs. T0, all P s $< .05$, large effects). A trend towards improvement was observed for subjective sleep quality ($p < .1$, large effect). Subjective total sleep time, sleep onset latency and wake time after sleep onset did not significantly change across the study.

Conclusion: The findings provide preliminary evidence that ACT as a group program might expand the therapeutic strategies for PI in terms of improving the patients' QoL.

0551

A NONINVASIVE APPROACH TO IMPROVE INSOMNIA IN A MILITARY COHORT

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Introduction: Insomnia is prevalent in soldiers post-deployment. Autonomic hyperarousal is a key mechanism for insomnia. High-resolution, relational, resonance-based, electroencephalic mirroring (HIRREM), a noninvasive neurotechnology for relaxation and auto-calibration of neural oscillations, uses auditory tones to reflect brain frequencies in near real time. We report the effects of HIRREM on insomnia (Insomnia Severity Index, ISI), hyperarousal (temporal high frequency electroencephalic amplitudes, THFEA), heart rate variability (HRV), baroreflex sensitivity (BRS), and mean arterial pressure (MAP) in a military cohort.

Methods: Eight males (7 active duty, median age = 31 years, range = 26-54) with at least one military deployment, enrolled in an open label, IRB-approved pilot study. Median baseline ISI was 15 (range =

10-28). Self-reported co-morbidities included mild TBI (5), and PTSD (5). THFEA was calculated from 1 minute epochs of temporal recordings (T3/T4, eyes closed) of high frequency amplitudes (23-36 Hertz) at baseline, the first 4, and last 4 HIRREM sessions. Serial values for sums of T3 and T4 amplitudes (microvolts, μV) were calculated. Blood pressure and heart rate were recorded in 7 subjects with spectral analysis for HRV and BRS measures, and calculation of MAP.

Results: Participants received a median of 13.5 (range = 10-22) ninety minute HIRREM sessions over 9 days. Median ISI score was reduced by -9.5 (range = -3 to -13, $p < 0.001$). Sums of T3 and T4 amplitudes decreased from baseline to the final HIRREM session (10.75 to 5.77 μV). HRV measured as standard deviation of the R-R interval (SDRR) increased by 16% ($p = 0.051$). Parasympathetic BRS by sequence analysis increased by 57% ($p = 0.095$) and MAP dropped (-8 mmHg, $p < 0.05$) without medication change.

Conclusion: HIRREM was associated with improved self-reported sleep as well as HRV, BRS, MAP, and reduced temporal high frequency amplitudes in this series of military participants.

Support (If Any): The Susanne Marcus Collins Foundation, Inc.

0552

TWO IS TWO TOO MANY: A THEMATIC ANALYSIS OF PATIENTS' PERSPECTIVE ON TREATMENT FOR COMORBID INSOMNIA AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Comorbid insomnia and obstructive sleep apnea (OSA) commonly co-occur in patients presenting to sleep disorders clinics. The aim of this study was to examine qualitative data on the patients' perspective of their condition and their experience with treatment at a multidisciplinary sleep clinic.

Methods: Twenty-nine clinic patients, who met criteria for insomnia disorder and OSA (mean age = 54, females = 19), completed a post-treatment interview either in individual or group format. All patients received standard evaluation, and the treatment plan, determined by the clinician, included cognitive-behavior therapy for insomnia (CBT-I) and/or positive airway pressure (PAP) for OSA. Transcribed audio recordings were analyzed using thematic analysis. Two trained raters independently coded each interview and then collated these initial codes into overarching themes. These themes were then refined in an iterative process until consensus was reached between the two raters.

Results: Three main themes were identified: 1) patients consider OSA and insomnia separate disorders, 2) both OSA and insomnia require treatment, and 3) unique considerations influence treatment preference. Insomnia and OSA were considered distinct sleep disorders, where insomnia was classified as a sleep onset and OSA as a maintenance problem. Both disorders required treatment because PAP and CBT-I had no effect on onset insomnia and OSA respectively. Although most patients favored sequential treatment starting with PAP, treatment preference was influenced by unique considerations. Patients emphasized the need for concurrent insomnia treatment, because insomnia could interfere with PAP use and reduce its effectiveness; using PAP while awake does not treat OSA. Furthermore, adhering to stimulus control was challenging whilst wearing a PAP mask.

Conclusion: This is the first study to describe the patients' perspective on having these comorbid sleep disorders. The findings indicate that patients recognize the importance of treating both disorders and articulate important treatment considerations when combining CBT and PAP.

0553

THE FEASIBILITY OF IN-LAB DREAM COLLECTION IN INSOMNIA SUFFERERS: PRELIMINARY DATA

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Introduction: Dream studies are limited in insomnia sufferers (INS). In-lab dream collection is the most reliable procedure to study dreams. This project is aimed at circumscribing the feasibility of in-lab dream collection in INS, considering their reported sleep difficulties and heightened level of hyperarousal.

Methods: Eight INS [Mean age = 39.0 (4.4)] and five good sleepers [GS; 37.0 (4.5)] underwent 5 consecutive PSG nights. At-home ambulatory measures were used during Nights 2 and 4 while Nights 3 and 5 consisted of in-lab REM dream collection. Dream recall frequency (DRF) was calculated while sleep onset latency (SOL) after each awakening was measured and defined as the time elapsed from the beginning of dream collection to the first epoch of stage 2.

Results: Preliminary independent sample t-tests revealed only a marginally significant difference of groups for DRF ($p = 0.11$), DRF being greater in INS than in GS (94% vs. 81%). While longer SOL was observed in INS than GS (51 vs. 22 minutes), groups did not significantly differ ($p = 0.16$). Then, subjective and objective sleep variables were assessed using paired sample t-tests. For GS, at-home and in-lab nights were characterized by significantly higher subjective TST ($p \leq 0.04$) and lower WASO ($p \leq 0.03$) than objective TST and WASO. For INS, lower values were observed for subjective in-lab WASO ($p = 0.04$) and at-home TST ($p = 0.04$). In-lab TST ($p = 0.6$) and at-home WASO ($p = 0.2$) were similar.

Conclusion: Because of the small sample size, caution should be used while interpreting these results. Still, they suggest that in-lab dream collection can be successfully conducted with INS. Higher DRF in INS might reflect their heightened level of hyperarousal. Interestingly, dream collection also appears to contribute to the underestimation of WASO in INS. It is possible that externally induced awakenings attenuate the importance given to sleep difficulties, INS feeling less distressed of being awake since the awakening is attributed to dream collection.

Support (If Any): CIHR (CB#86571).

0554

PERCEIVED STRESS APPEARS TO BE A SECONDARY ISSUE IN THE BEHAVIORAL TREATMENT OF CHRONIC INSOMNIA: MODELING EFFECTS FROM A WEB-BASED TREATMENT PROGRAM

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Introduction: Insomnia is often attributed to stress, but its actual role in clinical improvement is understudied. Results from a web-based sleep program (WBSP), based on behavioral principles, allowed modeling the impact of perceive stress after other treatment effects were controlled for.

Methods: Consenting chronic insomnia participants with internet access were recruited by outreach efforts. Primary insomnia participants were randomized to WBSP or Wait-list control groups. Inclusions and exclusions are described in a companion abstract from our group. Excluded participants were eligible for a observational side-study on the WBSP. Pittsburgh Insomnia Rating Scale (PIRS), Insomnia Severity Index (ISI), and Perceived Stress Scale (PSS) scores were obtained at baseline and 6 weeks. Linear mixed effects models were stepwise developed using Chi-square testing, using ISI scores (pre- and post-intervention) as dependent

variable to explore the relative contribution of pre- and post-intervention PSS scores after correction for pre- and post-intervention PIRS scores. With a larger N, initial modeling was done with the side-study data.

Results: Side-study participants with follow-up data numbered 154 (age 56.3 ± 11.4 , 88% female). The final selected model showed effects for PIRS (estimate = 0.385, $t = 20$ (df = 150), $p < 0.0001$), Time (-2.86, -4.40 (150), $p < 0.0001$), PIRS:Time interaction (0.042, 2.205 (150), $p = 0.042$), and PSS (-0.051, -2.206, $p = 0.029$). In the randomized trial, 30 of 51 (age 54 ± 12.0 , 90% female) GoTS participants provided follow-up data, with 40 of $n = 50$ (age 54.6 ± 12.6 , 80% female) controls doing likewise, and without baseline group differences. The final selected model showed effects for PIRS (0.324, 10 (66), $p < 0.0001$), main Group effect (-0.108, -0.18 (68), $p = 0.86$), Time (-3.92, -2.91 (66), $p = 0.005$), Time:Group interaction (-0.449, -0.57 (66), $p = 0.57$), and Time:PIRS interaction (0.10, 2.62 (66), $p = 0.011$). Here PSS did not test into the modeling series.

Conclusion: Both independent samples pointed to perceived stress having a relatively small independent influence on observed effects on ISI scores after an independent modeling of insomnia severity (PIRS) and time:group interactions. The results suggest that insomnia patients see perceived stress as an independent issue from the severity of insomnia as such.

0555

SLEEP DISTURBANCES AND DAYTIME IMPAIRMENTS IN INSOMNIA WITH AND WITHOUT MEDICAL COMORBIDITY

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Introduction: Little is known about the similarities and distinctions between insomnia with and without a comorbid medical disorder in terms of sleep disturbances and daytime impairments. The few studies that compared these two insomnia subtypes found mitigated results. The present study compared individuals who met criteria for insomnia with or without a comorbid medical disorder on measures of sleep and daytime functioning.

Methods: Participants were 14 adults with insomnia and a comorbid medical disorder (INS+MED), 22 with insomnia and no comorbidity (INS), and 17 good sleepers with a medical disorder (GS+MED). All completed a daily sleep diary for 1 week, a clinical interview, 2 nights of polysomnographic recording, and questionnaires assessing mental health, quality of life, fatigue, pain, sleepiness, work productivity, activity impairment, and daytime consequences of insomnia.

Results: Significant multivariate analyses of variance or covariance were followed by canonical correlation analyses for three contrasts: INS+MED vs. INS, INS vs. GS+MED, and INS+MED vs. GS+MED. The INS+MED group spent less time asleep and had more nighttime awakenings than the INS group on subjective measures of sleep. Also, the INS+MED group tended ($p = .07$) to report poorer physical functioning, more physical fatigue, and lower work productivity than the INS group. Compared to the GS+MED group, the INS group, but not the INS+MED group, was characterized by lower vitality, poorer social functioning, and better physical functioning. In contrast to the GS+MED group, insomnia interfered with social or leisure activities, and daytime mood in the INS+MED group but not in the INS group.

Conclusion: Insomnia comorbid with a medical disorder is associated with more severe sleep disturbances and daytime impairments than insomnia without comorbidity. Treatment of comorbid insomnia should be adapted accordingly.

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0556

SLEEP DISTURBANCES AND DAYTIME IMPAIRMENTS IN INSOMNIA WITH AND WITHOUT PSYCHIATRIC COMORBIDITY

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Introduction: A limited number of studies have examined sleep disturbances and daytime impairments (other than depressive or anxiety symptoms) in insomnia with and without a comorbid psychiatric disorder. The available evidence is equivocal whether or not sleep disturbances are more severe in comorbid insomnia. This research aimed to compare insomnia with and without a psychiatric disorder on measures of sleep and daytime functioning.

Methods: Participants were 16 adults with insomnia and a comorbid psychiatric disorder (INS+PSY), 22 with insomnia and no comorbidity (INS), and 15 healthy good sleepers (GS). All completed a daily sleep diary for 1 week, a clinical interview, 2 nights of polysomnographic recording, and questionnaires assessing mental health, quality of life, fatigue, pain, sleepiness, work productivity, activity impairment, and daytime consequences of insomnia.

Results: Significant multivariate analyses of variance or covariance were followed by canonical correlation analyses for three contrasts: INS+PSY vs. INS, INS+PSY vs. GS, and INS vs. GS. Comparisons between insomnia groups with and without a psychiatric disorder indicated similar sleep disturbances, but poorer physical health, and greater role impairment in the INS+PSY group. Individuals with a psychiatric disorder reported that their insomnia interfered more with mood, interpersonal relations, and quality of life compared to those without comorbidity. Contrasts with the GS group revealed that the INS group, but not the INS+PSY group, was characterized by more frequent subjective nighttime awakenings, lower vitality and social functioning, and higher physical fatigue and interference of insomnia with social or leisure activities. The INS+PSY group was characterized by poorer mental health and reduced work productivity.

Conclusion: Insomnia comorbid with a psychiatric disorder carries a greater burden for the individual than insomnia without a psychiatric disorder. Treatment should be adapted accordingly.

Support (If Any): This research was supported by a Canadian Institutes of Health Research doctoral scholarship awarded to the first author and by a Canadian Institutes of Health Research grant (no. 42504).

0557

DISTRIBUTION AND STABILITY OF INSOMNIA PHENOTYPES

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Introduction: Many recent literature reviews conclude that insomnia phenotypes, such as sleep onset insomnia (SOI) and sleep maintenance insomnia (SMI), lack temporal stability. However, we are only aware of a single investigation of this phenomenon. This early study suffered from a number of limitations, including a short follow-up period (4 months), failure to establish an insomnia diagnosis at baseline, use of non-standardized instruments, and a small sample size ($n = 328$), and the reported findings have not been replicated. Hence, the present study sought to reexamine the distribution and stability of insomnia phenotypes in a large cohort of individuals with insomnia.

Methods: A sample of 960 adults (47 ± 13 yo; 69% female) with DSM-IV diagnoses of insomnia disorder completed questionnaires assessing sleep parameters, including sleep onset latency (SOL) and wake time

after sleep onset (WASO). Participants completed the same questionnaires 1 year later.

Results: At baseline, 143 participants (14.9%) reported SOI (SOL > 30 min; WASO ≤ 30 min), 205 (21.4%) reported SMI (SOL ≤ 30 min; WASO > 30 min), and 349 (36.4%) reported mixed onset/maintenance insomnia (MI: SOL > 30 min; WASO > 30 min). Analyses revealed that 35.7%, 54.1%, and 55.2% of the SOI, SMI, and MI groups respectively reported the same phenotype at follow-up. The conditional distributions of phenotypes across time points revealed a significant association between phenotype and temporal stability ($\chi^2 = 16.85$; $p < .01$), such that the likelihood of temporal stability of phenotypes varied as a function of the phenotype. Specifically, a significant proportion of individuals with SOI at baseline no longer met SOI criteria at follow-up. This was not the case however for the SMI and MI groups.

Conclusion: Our data suggest that certain phenotypes of insomnia, such as SMI and MI are more stable than others, such as SOI. Future studies can help characterize these phenotypes in terms of demographics, morbidity, and insomnia severity.

Support (If Any): This study was supported by an investigator initiated research award to Dr. Christopher L. Drake from Merck & Co.

0558

NEXT-MORNING DRIVING PERFORMANCE AFTER MIDDLE-OF-THE-NIGHT ADMINISTRATION OF HYPNOTIC DRUGS: EVIDENCE FROM DUTCH ON-ROAD DRIVING STUDIES

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Introduction: Sleep maintenance problems are common, hence treatments enabling people to more rapidly fall asleep after middle-of-the-night (MOTN) awakenings, without impairing next morning alertness, are needed. The current literature review compared the effects of MOTN administration on morning driving ability, i.e. a potentially dangerous daily activity that can be impaired.

Methods: A literature search was conducted identifying on-the-road driving studies examining the effects of MOTN administration of hypnotics on morning driving performance. In a standardized 100-km highway driving test in normal traffic, subjects were instructed to drive with a steady lateral position and constant speed of 95 km/h. Primary outcome measure of the driving test was the Standard Deviation of Lateral Position (SDLP, cm), i.e. the weaving of the car.

Results: Four on-road driving studies were identified. Driving performance after MOTN administration of traditional benzodiazepine hypnotics was not examined. Zolpidem (10 mg and 20 mg, oral immediate release tablets) significantly impaired on-road driving in a dose-dependent manner, when tested 4 hours after MOTN administration. Also, gaboxadol (15 mg) and zopiclone (7.5 mg) significantly impaired next-morning driving after MOTN administration. Impairment with these drugs was worse than seen with a blood alcohol concentration (BAC) of 0.05%, i.e. the legal limit for driving in many countries. In contrast, buffered sublingual zolpidem tartate (3.5 mg) and zaleplon (10 mg and 20 mg) did not significantly affect driving 4 hours after MOTN administration. Except for sublingual zolpidem, all of the other medications are off label use for MOTN insomnia.

Conclusion: Driving was not affected 4 hours after MOTN administration of sublingual zolpidem tartate (3.5 mg) or zaleplon (10 mg and 20 mg). Significant driving impairment was found after MOTN adminis-

tration of zolpidem (10 and 20 mg), gaboxadol (15 mg), and zopiclone (7.5 mg).

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0559

RACE AS A MODERATOR IN INSOMNIA RISK FOR SUICIDAL IDEATION

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Introduction: Insomnia and suicidal ideation have been consistently positively correlated. Even when the effects of depressive symptoms, hopelessness, and anxiety are taken into account, insomnia symptoms are still associated with suicidal ideation. Little is currently known about the relationship between race and suicidal ideation, but a recent study by Hirsch and colleagues (2012) found that when the moderators for depression and suicide were examined simultaneously, hopelessness was a significant moderator only in Blacks, and trait hope was a significant moderator only in Whites. The current research seeks to determine the role of race in the relationship between insomnia and suicidal ideation.

Methods: In order to determine the role of race in the relationship between suicidal ideation and insomnia, a logistical regression analysis was conducted using an epidemiological database collected by Lichstein and colleagues (2004). The sample used in the database included 761 randomly selected adults, 29% black and 70% white, from 20 to 98 years of age. Participants filled out sleep diaries for two weeks in addition to the Beck Depression Inventory (BDI) and other questionnaires. The logistic model entered age, BMI, and BDI score without item 9 on step 1; race and insomnia status on step 2; and the race × insomnia status product variable testing the interaction on step 3, in predicting suicidal ideation, BDI item 9.

Results: Insomnia diagnosis was significantly correlated with suicidal ideation, $r = .09$, $p < .05$, and with BDI score, $r = .324$, $p < .05$. There was no significant interaction found between race and insomnia in predicting suicidal ideation ($p > .05$).

Conclusion: This research provides no evidence for a racial influence in the relationship between insomnia and suicidal ideation. These results support that health disparities do not play a role in suicidal ideation.

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0560

VULNERABILITY TO INSOMNIA: HIGH-FREQUENCY HEART RATE VARIABILITY MODERATES THE ASSOCIATION BETWEEN NEUROTICISM AND STRESS-RELATED CHANGE IN PRE-SLEEP AROUSAL

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Introduction: Characteristics of chronic insomniacs, such as a tendency to ruminate, heightened cognitive-emotional hyperarousal, and inadequate stress-coping abilities, are captured by the personality trait neuroticism and present among those vulnerable to sleep disturbances. The ability to dampen physiological arousal, inhibit distressing thoughts, and regulate negative affect following stress may help to distinguish between individuals who develop persistent sleep complaints from those who do not. Theoretical models linking parasympathetic nervous system (PNS) functioning, self-regulation, and health highlight individual differences in resting high frequency heart rate variability (HF-HRV) as playing a key role in the modulation of affective, cognitive, and physiological responses to stress.

Methods: Seventy-seven healthy young adults (50% Male; M_{age} 23 years; SD, 5.8) were brought into the laboratory and completed a personality inventory, the pre-sleep arousal scale (PSAS), and then rested quietly for 10 minutes while cardiovascular and respiratory physiology were recorded continuously. Participants completed the PSAS again at bedtime. Multiple regression was used to test whether resting HF-HRV moderated the association between neuroticism and stress-related changes pre-sleep arousal.

Results: Neuroticism was significantly related to change in pre-sleep arousal among those with lower resting HF-HRV, $\beta = .44$, $p = .01$, $\Delta R^2 = .05$, but unrelated among those with higher resting HF-HRV, $\beta = -.08$, $p = .59$. Supplemental analyses on the cognitive and somatic subscales of the PSAS revealed a cross-over interaction. Neuroticism had a positive association with stress-related change in somatic pre-sleep arousal among those with lower resting HF-HRV, $\beta = .56$, $p < .01$, and had a negative association with stress-related change in somatic pre-sleep arousal among those with higher resting HF-HRV, $\beta = -.35$, $p < .05$, $\Delta R^2 = .14$. Resting HF-HRV did not moderate associations between neuroticism and stress-related changes in cognitive pre-sleep arousal, $p > .05$. Higher resting HF-HRV appeared to buffer associations between neuroticism and stress-related changes in pre-sleep arousal.

Conclusion: These findings are noteworthy because pre-sleep arousal has been implicated in the development of both acute insomnia and chronic sleep disruption. Placed within a broader framework, these findings highlight the importance of self-regulatory processes for daily functioning, adaptability, and health.

0561

CORTICAL SOURCE IMAGING OF SLEEP EEG IN PRIMARY INSOMNIA

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Introduction: Previous sleep EEG investigations in insomnia have supported the concept of hyperarousal by demonstrating increases in high-frequency activity (HFA). We have demonstrated that in addition to a widespread global increase in HFA between primary insomnia (PI) subjects and good-sleeper (GS) controls, particularly evident during N2 sleep, there is a more temporally and regionally specific increase in alpha activity, most prominent during N3 sleep. In this study, we examined this difference in sleep EEG between insomnia subjects and controls by using cortical source imaging to determine whether specific brain regions were especially active even during deep NREM sleep in insomnia subjects.

Methods: Five minute continuous segments of 256 channel high-density EEG were selected from all-night sleep recordings from 9 non-depressed individuals with insomnia complaints (6 F) and 9 sex and age-matched controls without sleep complaints. Spectral analysis and cortical source imaging (sLORETA) of the segments were conducted to confirm the existence of EEG power differences similar to those observed in the all-night data, as well as examine the cortical localization of this activity. Differences in spectral density were assessed using unpaired t-tests, whereas statistical non-parametric mapping (SnPM) cluster testing was used to determine cortical areas significantly different between groups.

Results: Spectral analysis of source imaged data segments selected from deep sleep in PI subjects showed significantly more alpha activity (approximately 9-11 Hz) compared to similar segments selected from GS controls, consistent with the whole night analysis. Intriguingly, source imaging of this activity revealed that many of the cortical areas showing the most significantly increased alpha activity were primary or associative sensory areas.

Conclusion: These results suggest that even during the deepest stage of sleep, sensory areas in insomnia subjects may be still relatively active compared to controls and to the rest of the sleeping brain.

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0562

CHRONIC INSOMNIA IN PROFESSIONAL PILOTS OF COMMERCIAL AVIATION

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Introduction: For more than 30 years research in aviation medicine has focused on excessive sleepiness due to shift work and/or jetlag. However, chronic insomnia may also impair psychomotor performance for pilots in an operational environment where safety plays a vital role. But the frequency and the determinants of chronic insomnia (i.e. persistent sleep complaints between flight duty periods) in a population of professional pilots of commercial aviation remain unknown.

Methods: A cross-sectional survey was carried out between September 1st and November 5th, 2010. 612 pilots completed a questionnaire on socio-demographic characteristics, work conditions, sleep habits, excessive sleepiness, sleep complaints, indicators of occupational health and flight safety. These datasets were collected during a fitness test carried out in 3 aviation medicine centers. Logistic regression analysis was used to examine the associations among insomnia and these different variables.

Results: The preliminary results show that 16.7 % of the subjects suffer from chronic insomnia, defined as the association of ICD-10, DSM-IV, and ICSD-2 criteria. Factors associated with chronic insomnia are: evening typology, non-smoking, the number of hours (≥ 600) spent flying per year, excessive sleepiness between flight duties (Epworth ≥ 11), use of hypnotics, absenteeism, wish to change sectors or airlines, and involuntary sleep episodes in the cockpit.

Conclusion: Chronic insomnia is a common problem in professional pilots of commercial aviation, and it is associated with serious adverse effects. Data from our survey will help occupational physicians and medical examiners working with airline pilots to establish screening for chronic insomnia. However, in spite of our results, risk management in commercial aviation seems satisfactory, since flying remains the safest means of long-distance transportation for users.

0563

DIFFERENTIAL CORRELATES OF DAYTIME AND NIGHTTIME INSOMNIA SYMPTOM FREQUENCY

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Introduction: The frequencies with which daytime and nighttime symptoms of insomnia disorder occur are important considerations in assessment and diagnosis. A 3-day per week frequency criterion for nighttime symptoms has been proposed and later used in the DSM5.

To the best of our knowledge, frequency of daytime symptoms has not been studied. We examined relationships between daytime and nighttime symptom frequency and insomnia severity, dysfunctional beliefs about sleep, and excessive daytime sleepiness.

Methods: 110 sleep clinic patients participating in group Cognitive Behavioral Therapy for Insomnia between 2004 and 2013 provided baseline data on all of the following measures: Insomnia Severity Index (ISI), 10-item Dysfunctional Beliefs and Attitudes about Sleep Scale (BAS), and Epworth Sleepiness Scale (ESS). Participants also indicated the number of days/nights they experienced each of 10 nighttime and 9 daytime symptoms in the past week, which were then averaged to provide indices of weekly nighttime and daytime symptom frequency.

Results: On average, participants reported experiencing nighttime symptoms 3.2 days per week (median = 3.2; mode = 4.0) and daytime symptoms 3.5 days per week (median = 3.4; bi-modal, mode (a) = 3.0, (b) = 4.0). Both nighttime and daytime symptom frequency were significantly correlated with ISI scores ($r = .49, p < .001$ and $r = .54, p < .001$; respectively) but not with ESS ($r = -.06$ and $r = .05, p$ values $> .05$). Additionally, daytime symptom frequency was significantly correlated with BAS ($r = .44, p < .001$) but nighttime symptom frequency was not ($r = .14, p = .16$).

Conclusion: Daytime symptom frequency is an important yet understudied aspect of insomnia disorder. Dysfunctional beliefs about sleep were related to daytime but not nighttime symptom frequency, underscoring the importance of targeting dysfunctional beliefs in insomnia treatment.

0564

AN ANALYSIS OF CONVERGENT AND DISCRIMINANT VALIDITY OF THE PSQI IN A COLLEGE SAMPLE

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Introduction: The Pittsburgh Sleep Quality Index (PSQI) is the most widely used measure of sleep. Although previous studies have examined the PSQI in young adults, to our knowledge, no published studies have examined its validity with college students. Among other factors, irregular schedules and dorm living may set college students apart from other young adults. The current study examines convergent validity of this questionnaire with sleep diaries and explores discriminant validity with a widely used measure of depression in a college sample.

Methods: Participants were 1039 undergraduate students from a large public university in Texas (U.S.); 173 were excluded for missing data, resulting in $N = 866$ (74.1% female; mean age 20.4 years [$SD = 4.1$]). Participants completed a questionnaire battery, from which the current study examined the PSQI, Quick Inventory of Depressive Symptomatology (QIDS), and one week of sleep diaries. A smaller clinical sample of undergraduate students with insomnia will also be examined; these results will be presented at the conference.

Results: The PSQI had a mean Global Score of 5.64 ($SD = 2.79$). Cronbach's alpha for the PSQI was $\alpha = .60$. The PSQI showed good convergent validity between the total score and sleep quality ($r = .46$), sleep efficiency ($r = .34$), and total sleep time ($r = .17$) measured by concurrent sleep diaries (all $ps < .05$). The PSQI Global score and QIDS total score correlated at $r = .48$.

Conclusion: Overall, the results of this study indicate the PSQI is valid measure of sleep quality in a college population; however, caution should be used when interpreting the PSQI Global Score. The PSQI

had a moderate relationship with the QIDS total score, indicating high scores may be influenced by depressive symptomatology.

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0565

CHANGE IN SELF-REPORTED INSOMNIA SEVERITY FOLLOWING ADAPTIVE SERVO-VENTILATION THERAPY IN PATIENTS WITH COMPLEX SLEEP APNEA

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Introduction: Emerging research shows a high rate of comorbidity between insomnia and sleep-disordered breathing. Scant research has examined PAP therapy adherence in insomniacs, albeit insomniacs have been shown to experience greater expiratory pressure intolerance when exposed to positive airway pressure (PAP), which may be associated with iatrogenic central apneas. As a result, these patients may qualify for adaptive servo-ventilation (ASV), which treats both OSA and CompSA. This chart review examined the association between ASV use and change in insomnia severity.

Methods: Data were collected at Maimonides Sleep Arts & Sciences, Albuquerque, NM from 2011 to 2013. Qualified patients met these criteria: moderate or worse insomnia symptoms ($ISI \geq 15$) with diagnosed co-morbid OSA or UARS; completed ASV titration; prescribed ASV; and, subjective or objective evidence of PAP use as well as outcomes captured at most recent follow-up. Two groups were contrasted based on average weekly ASV use: Users (use ≥ 20 hrs; $n = 113$) and Partial Users (use < 20 hrs; $n = 32$).

Results: The 145 patients comprised: 57% male, 60% White, 28% college educated, mean (SD) age 55.34 (13.34) and BMI 30.19 (7.06). Users averaged [mean (SD)] 6.15 (1.88) hrs/night on ASV and Partial Users averaged 1.25 (0.9) hrs/night. User ISI scores decreased by 7.58 (6.50) from intake to most recent follow-up [18.99 (3.26) vs 11.41 (6.27), $p = 0.001$, $d = 1.52$] compared to 3.9 (6.58) [19.69 (4.09) vs 15.78 (6.68), $p = 0.006$, $d = 0.71$] for Partial Users. Between subjects analysis showed a significant time by group interaction for ASV and Partial Users [$F(1,143) = 7.948$, $p = .005$]. Hours of use correlated positively with magnitude of ISI change (more hours, less insomnia) ($r = .292$, $p = .001$).

Conclusion: Regular ASV and partial ASV use were associated with improvement in ISI scores. Regular ASV use was associated with nearly double the insomnia improvement compared to partial ASV use. Randomized controlled trials are warranted to determine whether or not ASV therapy is an efficacious treatment for insomnia.

0566

EFFECT OF PAIN ON PERCEIVED BENEFITS OF COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA

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Introduction: Research has demonstrated that cognitive behavioral therapy for insomnia (CBTI) is effective for individuals experiencing physical pain but the relative perceived benefit of CBTI among patients with and without pain is not known.

Methods: 47 individuals (49% men, age 54.9 ± 15.7 y) referred by a sleep physician to group CBTI and meeting quantitative criteria (QC) for insomnia (minutes to fall asleep or time awake after sleep onset > 30 min at least three nights per week) completed the SF-36 RAND at baseline. Participants also completed sleep diaries and a post-treatment

satisfaction questionnaire. The two items from the pain subscale of the SF-36 RAND that assess the severity of, and extent to which, bodily pain interfered with normal work were summed and used to classify patients by pain experience based on quartile scores.

Results: Based on quartile classification, participants with the highest self-reported pain perceived significantly less benefit from treatment than participants with the lowest self-reported pain in the following domains: insomnia ($t = 2.18$, $p = .048$), daytime energy ($t = 2.23$, $p = .040$), coping with everyday stress ($t = 2.93$, $p = .011$), enjoying life more ($t = 2.83$, $p = .014$), and alleviating low moods ($t = 2.18$, $p = .043$). These differences were present despite an absence of any significant between group differences in changes in diary based sleep indices (p -values $> .66$), including time awake after sleep onset, total sleep time, and sleep onset latency.

Conclusions: These findings suggest that while those with and without pain do not differ in perceived improvement in prospectively measured sleep following CBTI, these groups differ in their reflection on global treatment satisfaction in domains beyond sleep. Past research has shown that the effects of CBTI do not generalize to pain. This suggests that continued experience of pain at post-treatment may impact the perception of benefits, leading to lower overall treatment satisfaction and less reported improvement in various domains.

0567

SLEEP AID USE IN BREAST CANCER SURVIVORS WITH CHRONIC INSOMNIA DURING BEHAVIORAL TREATMENT

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Introduction: Breast cancer survivors (BCS) suffer from chronic insomnia at disproportionately high rates compared to other cancer survivors and the general population. Less understood are the pharmacological habits of BCS. Most healthcare providers are familiar with BCS use of prescription medications, but over the counter (OTC) and homeopathic sleep aid (melatonin, valerian, herbs) habits are poorly understood.

Methods: This secondary analysis of a randomized trial examines the use of prescription, OTC, and homeopathic sleep aids in BCS with chronic insomnia. In addition, frequency of depression and pain medication use was evaluated because of the effect on sleep. Sixty women enrolled in a trial testing cognitive behavioral therapy for insomnia (CBTI) versus behavioral placebo (desensitization) provided baseline data about sleep aid use (frequency/week), demographic characteristics, cancer stage, and time since diagnosis. An ANOVA was used to evaluate the frequency of sleep aid use and the relationship to demographic and self-reported sleep data.

Results: The participants were predominantly middle aged ($M = 53.13$ years), Caucasian college graduates. Nearly half the women started to use sleep aids at or after breast cancer diagnosis (47%) and that use persisted long after completing acute cancer treatment. Prescription sleep medications were used by the largest percentage of BCS (32%), followed by OTC sleep medications (23%) and homeopathic therapies (17%). The most common prescription medication was Ambien ($n = 15$); OTC aid was Benadryl ($n = 8$); and homeopathic medication was melatonin ($n = 5$).

Conclusion: The use of sleep medications by BCS with insomnia persists long after acute cancer treatment. Healthcare providers prescribed sleep medication to 47% of the BCS in this behavioral study; but it is possible BCS may be taking medications without the knowledge of the provider. The use of so many different types of sleep aids could lead to inadvertent medication interactions and poor outcomes of care.

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0568

A MULTI-PHENOTYPE GENOME-WIDE ASSOCIATION STUDY OF INSOMNIA-RELATED SLEEP TRAITS

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Introduction: While multiple family studies have established a heritable genetic component to insomnia, subsequent genome-wide association (GWA) mapping studies have had limited success in identifying and validating genetic polymorphisms that account for variation in insomnia. Recently, multi-trait GWA methods have been shown to increase power in GWA studies under many different scenarios. Therefore, in the current study, we took a multi-trait GWA approach to identify genetic variation associated with insomnia.

Methods: We utilized existing data from the Framingham Heart Sleep Heart Health Study (1995-1998) for the current analysis. Of the 2,097 subjects within the study, 1,941 individuals had baseline data as well as Affymetrix 500K GeneChip genotype data available. We used autosomal SNP data and the genomwide-complex trait analysis (GCTA) approach to assess genetic correlation between pairs of insomnia related traits, and among a subset of 1,447 individuals that were no more closely related than cousins, traits with significant genetic correlation were then jointly mapped using the MultiPhen multi-trait mapping method.

Results: GCTA analysis identified significant positive genetic correlations between pairs of trouble falling asleep; waking at night and difficulty resuming sleep; and waking too early and unable to resume sleep (minimum genetic correlation of 0.52). The most significant association ($p = 7.1 \times 10^{-7}$) was for a SNP within an intron of the RAR-Related Orphan Receptor A (RORA) gene. RORA is a candidate gene for insomnia-related phenotypes as it is known to directly regulate the circadian rhythm CLOCK genes. Further, SNPs in RORA have been identified in GWA scans of diseases related to insomnia including post-traumatic stress disorder and depression. Gene-based analysis of our multi-trait results also validated the catechol-O-methyltransferase (COMT) gene ($p = 1.8 \times 10^{-5}$) as associated with insomnia-related traits.

Conclusion: These results demonstrate the potential of multi-trait mapping of genetically correlated, insomnia-related traits to identify genetic variations that explain the heritable component of insomnia.

0569

FAMILIAL AGGREGATION OF INSOMNIA: A CASE-CONTROL STUDY

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Introduction: A positive family history of insomnia has been identified as a predisposing factor to new onset insomnia. However, few studies have systematically investigated this risk factor. The present study examined the familial aggregation of insomnia using a family case-control design.

Methods: From a sample of a larger epidemiological study, probands ($n = 71$ Mage = 49.1, SD = 17.4; 25.4% male) with insomnia syndrome and sex- and age-matched controls (i.e., good sleepers with no history of insomnia; $n = 68$, Mage = 49.0, SD = 14.1) were solicited to invite their first-degree relatives and spouses to participate. Relatives ($n = 190$,

Mage = 52.5, SD = 17.2; 32.5% male) and spouses (n = 53, Mage = 52.5, SD = 13.4; 28.2% male) who agreed to participate completed a questionnaire assessing the nature, severity, and frequency of sleep disturbances, daily sleep patterns, impairments of daytime functioning due to insomnia, as well as sleep-aid utilization (e.g., medication, meditation). Assessment of insomnia risks were estimated by comparing the two samples of proband- and control-relatives. Spouses and controls were used as comparison groups to assess the relative contribution of shared environment to insomnia risk.

Results: Analyses revealed that 74.0% of probands had at least one relative with insomnia compared to 44.2% of controls and 26.9% of probands had a spouse with insomnia compared to 22.2% of controls. Probands were 3.60 (95% CI = 1.96, 6.64) times more likely to have at least one relative with insomnia compared with controls. No significant increased risk for insomnia was observed for spouses of probands compared with controls (OR = 1.29, 95% CI = 0.37, 4.52).

Conclusion: These results demonstrate a strong familial aggregation of insomnia. Additional research is warranted to further clarify the relative contribution of genetic and environmental factors in insomnia.

Support (If Any): This study was supported by the Canadian Institutes of Health Research (MOP42504) and (127383).

0570

EXAMINING THE CLINICAL RELEVANCE OF QUANTITATIVE CRITERIA FOR INSOMNIA IN TREATMENT SEEKING INSOMNIA PATIENTS

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Introduction: Insomnia is diagnosed based on subjective reports and clinical judgment. Quantitative criteria (QC) for insomnia (> 30 minutes sleep onset latency or wake after sleep onset at least three nights per week) have been previously proposed and validated in an epidemiological study. Our aim was to evaluate the clinical relevance of QC among individuals seeking treatment for insomnia in a sleep clinic.

Methods: 151 individuals (43% men, age 47.9 ± 14.8) referred by sleep specialists to group cognitive behavioral therapy for insomnia (CBTI) completed sleep diaries and a post-treatment satisfaction questionnaire. Individuals were categorized into groups based on whether they met QC for insomnia or not (non-QC).

Results: At baseline, non-QC participants slept longer ($t = 4.19$), had a shorter sleep onset latency ($t = -3.82$), and spent less time awake after sleep onset ($t = -5.93$; all p values < .01). The groups did not differ significantly in age or the number of nights they used medications for sleep (p values > .15). Non-QC and QC individuals also did not differ significantly in their overall satisfaction with the treatment program or perceived benefits from treatment of insomnia and in domains outside of sleep (e.g. energy level, alleviating low moods; all p -values > .05 [except productivity, $p = .03$]). However, unlike QC participants, whose post-treatment sleep diary reflected significant increases in sleep efficiency ($t = 10.00$), decreases in sleep onset latency ($t = -6.96$) and decreases in wake after sleep onset ($t = -9.84$, all p values < .01), non-QC participants had no significant changes in these measures ($p > .16$).

Conclusion: Ratings of treatment satisfaction provided by participants seeking treatment at an outpatient sleep clinic reveal that CBTI is associated with perceived benefit in both sleep and non-sleep domains; although diary based insomnia parameters did not improve statistically in the non-QC group. These findings suggest that quantitative criteria for insomnia may be less relevant in clinical settings than in research.

0571

CHARACTERISTICS OF INSOMNIA IN PREGNANT WOMEN ENROLLED IN A STUDY OF CBT FOR INSOMNIA

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Introduction: Poor sleep is a frequent complaint often overlooked as a normal part of pregnancy; yet, relatively little is known about insomnia disorder during pregnancy.

Methods: Pregnant women (gestational ages 18-32 weeks) were enrolled in a treatment study of cognitive behavioral therapy for insomnia (CBTI). Eligible women who met DSM-IV criteria for insomnia and had no co-morbid affective or sleep disorders were recruited from community obstetric clinics. At baseline, participants completed an insomnia history timeline, the Insomnia Severity Index (ISI) and one week of sleep diaries.

Results: Fifteen women (age 32.1 ± 5.6) with a mean gestational age of 27 weeks (SD = 4.5 weeks) have enrolled in this study to date. Forty percent of women reported having at least one previous insomnia episode. Seventy three percent reported the current episode began during their current pregnancy. The ISI average score was 16.5 (SD = 4.1), with 46.7% of participants reporting being “very dissatisfied” and “much distressed” with their sleep. Based on sleep diaries, the average sleep efficiency was 79% (SD = 6.1) with women on average taking 28.3 (SD = 19.8) minutes to fall asleep, waking 2.8 (SD = 1.3) times per night, and being awake for a total of 56.9 (SD = 37.7) minutes per night.

Conclusion: Pregnant women enrolling in a study of non-pharmacological treatment for insomnia present with moderately severe insomnia, sleep patterns characterized by long time awake after sleep onset, and low sleep satisfaction scores. These findings suggest that insomnia during pregnancy warrants clinical attention and emphasizes the importance of demonstrating effective treatment in this population.

0572

POTENTIAL CAUSES LEADING TO LOW EXERCISE CAPACITY IN MALES BY AN ANALYSIS OF STRUCTURAL EQUATION MODELING

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Introduction: This study was aimed to identify risk factors causing low exercise capacity, the most powerful male-specific non-aged-limited predictor for mortality.

Methods: Of 521 community-based males (46.6 ± 7.5 years), the anthropometric, pulmonary functional, sleep polysomnographic and exercise testing measures were processed by structural equation modeling (SEM) to examine the potential factors of interest and mutual modulations underlying Low Exercise Capacity.

Results: By preliminary path SEM, beyond on Low Exercise Capacity, latent variables Obesity, Impaired Lung Function, Superficial Sleep and Sleep Disordered Breathing were found individually loading on body-mass-index, waist-hip-ratio; percentage-predicted values of forced expiratory volume in the first second, forced ventilatory capacity, maximal ventilatory volume and lung diffusion for carbon monoxide; total sleep time, percentage of slow wave sleep, sleep efficiency; and lowest oxygen saturation, percentage of total period of oxygen saturation < 90%, apnea-hypnea-index, respectively. Additionally, Non-regular Exercise based on self-reported physical activity also presented positively linking to Low Exercise Capacity. By comprehensive advanced SEM analysis, the well-fitted final model (0.940, 0.913 and 0.067, in GFI, NNFI and RMSEA, respectively) showed that Impaired Lung Function, Obesity

and Superficial Sleep as well as Non-regular Exercise directly led to Low Exercise Capacity, on which however Sleep Disordered Breathing demonstrated an indirect effect modulated by Obesity. Where, significant associations presented among former two latent factors and Non-regular Exercise.

Conclusion: Physical inactivity, obesity, and impaired lung function concomitant with their mutual interactions, superficial sleep alone directly as well as sleep disordered breathing modulated by obesity rather indirectly co-underlay the low exercise capacity in males.

0573

CORRELATION BETWEEN THE LATIN-AMERICAN SCALE OF SLEEP QUALITY (LASSQ) AND SLEEP ARCHITECTURE IN PATIENTS WITH SLEEP DISORDERS

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Introduction: Since 1989, Pittsburgh Sleep Quality Index has been widely accepted for clinical evaluation and research purposes, however, almost 25 years after, some faults have been identified, mainly concerned with its applicability for populations with no extreme climatic changes, and with the interpretation of the cut-off only with 2 sleep quality categories. We have introduced the LASSQ, it is designed to evaluate Sleep Quality, and is composed by 20 items. In previous pilot studies, LASSQ has obtained a very acceptable reliability (Chronbach's $\alpha = 0.87$); and validity (with exploratory factorial analysis and varimax rotation, we identified that LASSQ is integrated by three factors named Sleep Quality, Insomnia and Sleep disorders).

Methods: This is a prospective research that included 28 patients (47.1 years old, 13 male / 15 female) with PSG diagnosis (OSAS = 80.8%, Primary Snoring = 7.6%, Periodic Limb Movement Sleep = 11.6%). All patients were asked to respond the LASSQ. Spearman Correlation test were performed to determine the relationship between PSG and LASSQ. All participants gave their informed consent signature.

Results: We identified a non significant correlation between LASSQ with age, Body Mass Index, Total Sleep Time, Sleep Latency, Light Sleep, REM Sleep and Apnea / Hypopnea Index; however LASSQ obtained a negative correlation with NREM sleep percentage ($\rho = -0.417$, $p < 0.01$) and a positive correlation with Periodic Limb Movement Index ($\rho = 0.382$, $p < 0.04$).

Conclusion: Despite the small sample size, we identified that an increment in the LASSQ total score (the worsening of sleep quality) was related to a decrement of NREM sleep, and an exacerbation of muscular diseases associated with sleep. It is necessary to increase the sample size including participants of different latin-american cities.

Support (If Any): National Research System, National Council of Science and Technology.

0574

INSOMNIA PATIENTS WITH ANXIETY OR BENZODIAZEPINES USE: POLYSOMNOGRAPHIC FEATURES

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Introduction: Insomnia is a prevalent condition worldwide. High levels of anxiety is frequently evident in patients with insomnia and one of the more common kinds of drugs used to treat anxiety and sleep conditions are benzodiazepines.

Methods: On this study we included 150 insomnia patients and 50 GS. Subjects underwent an overnight PSG study. Our main objective was to explore the different sleep parameters in insomnia patients with anxiety (Inso+GA) or insomnia patients with benzodiazepines use (Inso+BZ), compared to a group of primary insomnia (PI) as well as to a group of good sleepers (GS).

Results: In TST, TWT, WASO, SEI and SL we found significant differences when comparing the GS group with the PI, Inso+GA and Inso+BZ. Stage 1. Inso+BZ (56.1 ± 2.44) vs GS (44.9 ± 0.9) and PI (45.02 ± 2.76); PI vs Inso+BZ. Stage 2. PI (187.7 ± 6.1) vs GS (225.09 ± 1.97), Inso+GA (220.3 ± 3.3), Inso+BZ (243.2 ± 6.8); Inso+BZ vs Inso+GA. Stage 3. GS vs PI (243.2 ± 6.8), Inso+GA (243.2 ± 6.8) and Inso+BZ (243.2 ± 6.8); PI vs Inso+GA and Inso+BZ; Inso+GA vs Inso+BZ. Stage 4. Inso+GA (243.2 ± 6.8) vs GS (243.2 ± 6.8), PI (243.2 ± 6.8) and Inso+BZ (243.2 ± 6.8); Inso+BZ vs GS and PI. REM. GS vs PI, Inso+GA and Inso+BZ; PI vs Inso+BZ. SOREM. GS vs Inso+GA and Inso+BZ; Inso+GA vs PI and Inso+BZ. ANOVA (Post hoc Bonferroni) * ($P \leq 0.05$), ** ($P \leq 0.05$) and + ($P \leq 0.05$).

Conclusion: Our data indicate that there are several significant changes in PSG parameters in patients with GS, PI and insomnia secondary to anxiety and in patients who use benzodiazepines.

0575

EFFICACY OF PACED BREATHING FOR INSOMNIA: ENHANCES VAGAL ACTIVITY AND IMPROVES SLEEP QUALITY

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Introduction: Poor sleep quality and the daytime functional impairment of insomnia sufferers has been considered to be associated with autonomic nervous system dysregulation. The possibility of modulating autonomic imbalance in order to enhance sleep quality has also not well studied. We have investigated the daytime autonomic functioning of insomnia sufferers and evaluated the efficacy of controlled respiratory frequency on cardiac activity and sleep quality.

Methods: Five sessions of paced breathing training for each frequency, the slow respiration frequency (0.1 Hz) and control frequency (0.2 Hz). All participants had assessed autonomic functioning under both 0.1 Hz and 0.2 Hz training sessions. Sleep examinations were performed by polysomnography in order to evaluate objective sleep quality.

Results: The insomnia sufferers showed significantly lower daytime R-R intervals compared with the controls ($p = .35$). After paced breathing at the frequency of 0.1 Hz, the heart rate oscillation was significantly enhanced and there were also significantly increased R-R intervals and total power of heart rate variability among the insomnia sufferers. Sleep onset latency (SOL) was significantly decreased ($p < .001$) and sleep efficiency (SE) were significantly increased ($p = .02$) on the night after controlling of the respiration rate to 0.1 Hz. Moreover, there were a positive correlation between SE and R-R interval of HRV, and a negatively correlation between SOL and delta power activity during NREM sleep among the insomnia individuals.

Conclusion: These findings indicate that there is a sympathovagal imbalance during daytime among insomnia individuals. However, this lower parasympathetic activity can be modulated by simple paced breathing training, which modifies the imbalance in autonomic nervous functioning and improves sleep quality.

0576

THE MODULATION OF SLEEP CONTINUITY THROUGH TRANSCRANIAL DIRECT CURRENT STIMULATION (tDCS)

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Introduction: The aim of this study was to provide proof-of-concept that sleep continuity in healthy humans can be modulated by local activity changes of the cerebral cortex through the non-invasive brain stimulation technique transcranial direct current stimulation (tDCS). This proposition is based on preclinical work suggesting that sleep emerges from synchronized deactivation in a cortico-thalamo-cortical feedback-loop and human studies indicating an association between cortical deactivation and sleep.

Methods: Eighteen healthy individuals (7 men, aged 40-65 yrs) underwent a within-subject, repeated measures protocol across five nights in the sleep laboratory. One adaptation night was followed by a baseline night and three experimental nights with polysomnographic monitoring from 11:00 PM to 7:00 AM. A repetitive tDCS protocol (anodal activation, cathodal deactivation and sham stimulation) was applied at 10:15 PM directly prior to sleep in the experimental nights (bifrontal stimulation, 1 mA on each side, parietal reference electrodes, using a protocol that has been shown to induce robust after-effects of at least 2 hrs). The stimulation conditions were implemented in a counterbalanced order and were separated by one week to prevent carry-over effects.

Results: A within-subject repeated-measures ANOVA with the factor stimulation condition (activation, deactivation, sham) revealed a significantly decreased total sleep time in the activation (380.6 ± 48.8 min) compared to the deactivation (408.1 ± 31.4 min) and sham condition (402.3 ± 33.4 min) (main effect $p < .05$; post-hoc contrasts $p < .05$), primarily driven by a reduction of stage 2 sleep in the activation condition. The intervention was well tolerated and the participants were unaware of the stimulation conditions.

Conclusion: This study provides first evidence that sleep continuity in healthy individuals can be modulated by local cortical activity changes through tDCS. Future studies are needed to test whether disturbed sleep in patients with insomnia can be improved.

Support (If Any): Intramural funding.

0577

GROUP COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA IN VETERANS

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Introduction: Insomnia is the most common sleep disorder among veterans. Given the adverse impact of insomnia on both mental and physical health, effective treatments are needed within the Veterans Health Administration (VHA) system. Group cognitive behavioral therapy for insomnia (CBT-I) provides a viable option for treatment but no off-the-shelf manuals that could be readily implemented within VHA settings exist. Ideally, a group-based treatment protocol would be adapted from the 1:1-based protocol already implemented within the VHA. This study reports the feasibility and acceptability of such a protocol.

Methods: A one-armed study was conducted in a real world VHA hospital setting to test feasibility, acceptability, and preliminary promise of a manualized group CBT-I protocol that was explicitly adapted from the existing 1:1 CBT-I VHA protocol. Veterans with insomnia ($n = 21$) participated in one of four consecutive CBT-I treatment groups.

Results: We found medium to large effect sizes for questionnaire and sleep diary measures, including sleep onset latency ($ES = .97$), awakenings during the night ($ES = .54$), sleep efficiency ($ES = .61$), insomnia scores ($ES = 1.08$) and dysfunctional beliefs about sleep ($ES = .50$). Improvements in insomnia symptoms were maintained over one month. Recruitment and retention rates were good. Rates of attrition were low (9.53%) and happened late in the treatment. Those who completed the treatment reported the treatment was very helpful overall, particularly the behavioral components.

Conclusion: Overall, we found this manualized group CBT-I treatment was acceptable and feasible. If further research finds the treatment to be effective, the manual could be readily disseminated to CBT-I providers within the VHA, potentially improving sleep of thousands of Veterans and service members.

Support (If Any): This material is the result of work supported with resources and the use of facilities at the Minneapolis VA Medical Center, Minneapolis, MN and the McGuire Veterans Affairs Medical Center, Richmond, VA.

0578

EFFECTS OF LOW-DOSE ESTRADIOL AND VENLAFAXINE ON INSOMNIA SYMPTOMS AND SUBJECTIVE SLEEP QUALITY IN PERIMENOPAUSAL AND POSTMENOPAUSAL WOMEN WITH HOT FLASHES

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Introduction: Sleep complaints are common in midlife women with vasomotor symptoms, but the relative effects of pharmacologic treatments on menopause-related sleep disturbance are uncertain.

Methods: To determine effects of low-dose 17 β estradiol and low-dose venlafaxine XR on insomnia symptoms and subjective sleep quality in menopausal women with hot flashes, the MsFLASH multicenter clinical trial network conducted a 3-arm double-blind clinical trial that randomly assigned 339 healthy perimenopausal and postmenopausal women (mean age 54.6 years) with ≥ 2 bothersome hot flashes per day in a 2:2:3 ratio to 17 β estradiol 0.5 mg/day ($n = 97$), venlafaxine XR 75 mg/day ($n = 96$) or placebo ($n = 146$) for 8 weeks. Insomnia symptoms (Insomnia Severity Index [ISI]) and subjective sleep quality (Pittsburgh Sleep Quality Index [PSQI]) at week 4 and 8 were pre-specified secondary outcomes.

Results: At baseline, mean (SD) hot flash frequency was 8.1/day (5.3), mean ISI was 11.1 (6.0), and mean PSQI was 7.5 (3.4); 331 women (98%) provided ISI data and 320 women (94%) provided PSQI data at follow-up. Mean (95% CI) change in ISI at week 8 – baseline was -4.1 points (-5.3 to -3.0), in the estradiol group, -5.0 points (-6.1 to -3.9) in the venlafaxine group, and -3.0 (-3.8 to -2.3) in the placebo group (p overall treatment effect vs. placebo 0.09 for estradiol and 0.007 for venlafaxine). Mean (95% CI) change in PSQI at week 8 – baseline was -2.2 points (-2.8 to -1.6) in the estradiol group, -2.3 points (-2.9 to -1.6) in the venlafaxine group, and -1.2 (-1.7 to -0.8) in the placebo group (p overall treatment effect vs. placebo 0.04 for estradiol and 0.06 for venlafaxine).

Conclusion: Among healthy menopausal women with hot flashes, both low dose oral estradiol and low-dose venlafaxine compared with placebo modestly reduced insomnia symptoms and improved subjective sleep quality at 8 weeks of follow-up.

0579

CLINICAL PROFILE OF SUVOREXANT OVER 3 MONTHS IN ELDERLY PATIENTS WITH INSOMNIA: SUBGROUP ANALYSIS OF PHASE-3 DATA

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Introduction: Suvorexant is being investigated as a first-in-class orexin-receptor-antagonist treatment for insomnia. Phase-3 trials evaluated age-adjusted (non-elderly/elderly) dose-regimes of 40/30 mg and 20/15 mg. Previously-reported results in the combined-age population showed that suvorexant was effective and generally well-tolerated. Here we report results for pooled-data in the elderly subgroup.

Methods: The pooled efficacy-analysis was prespecified and included elderly data from two similar randomized, double-blind, placebo-controlled, parallel-group, 3-month trials in elderly (≥ 65 y) and non-elderly (18-64 y) insomnia patients. Fewer patients were assigned to 20/15 mg than 40/30 mg or placebo. Efficacy was assessed by patient-reported-outcomes (PRO), and by objective polysomnographic (PSG) endpoints in a subgroup of ~75% of patients. Safety was assessed by adverse events (AEs), with systematic assessment for special considerations including residual effects, abuse potential, suicidality, and cataplexy. The pooled safety-analysis included elderly data from the 3-month trials plus 3-month data from a 1-year safety trial of 40/30 mg.

Results: The numbers of elderly patients in the efficacy-analysis of PRO endpoints were 30 mg = 313, 15 mg = 198, placebo = 307. In elderly patients, suvorexant 30 mg improved PRO and PSG measures of sleep-maintenance (subjective-total-sleep-time, wakefulness-after-persistent-sleep-onset) and sleep-onset (subjective-time-to-sleep-onset, latency-to-persistent-sleep) compared to placebo at the earliest time-points (Week-1 for PRO and Night-1 for PSG measures) and Month-3 ($p < 0.05$). Results were similar for 15 mg, except for the PRO and PSG onset measures at Month-3 ($p = 0.05$ and $p = 0.09$, respectively). The numbers of elderly patients in the safety-analysis were 30 mg = 627, 15 mg = 202, placebo = 469. Suvorexant was generally well-tolerated in elderly patients with few discontinuations due to AEs (30 mg = 6.4%, 15 mg = 3.5%, placebo = 5.5%). The most frequent AE was somnolence (30 mg = 8.8%, 15 mg = 5.4%, placebo = 3.2%) which was generally transient and mild-to-moderate in intensity.

Conclusion: Suvorexant 30 mg and 15 mg were effective and generally well-tolerated over 3-months in elderly insomnia patients. Given the FDA's current emphasis on using the lowest effective dose for insomnia, the 15 mg data are likely to be of most relevance for physicians in the US.

Support (If Any): Merck.

0580

CLINICAL PROFILE OF SUVOREXANT 20/15MG IN PHASE-3 TRIALS OF PATIENTS WITH INSOMNIA

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Introduction: The orexin receptor antagonist suvorexant is being investigated as a treatment for insomnia. Phase-3 trials evaluated two age-adjusted (non-elderly/elderly) dose-regimes of 40/30 mg and 20/15 mg. Given the FDA's current emphasis on using the lowest effective dose for insomnia we report here results for pooled 20/15 mg data.

Methods: The pooled Phase-3 efficacy analysis was pre-specified and included data from two similar randomized, double-blind, placebo-controlled, parallel-group, 3-month trials in non-elderly (18-64 y) and elderly (≥ 65 y) patients with primary insomnia. Fewer patients were

assigned to 20/15 mg than 40/30 mg or placebo. An optional 3-month double-blind extension was included in one trial. Both trials included a double-blind placebo-controlled run-out to assess rebound-insomnia and withdrawal. Efficacy was assessed by patient-reported-outcomes (PRO), and by objective polysomnographic (PSG) endpoints in a subgroup of ~75% of patients. Safety was assessed by adverse events (AEs), with systematic assessment for special considerations including residual effects, abuse potential, suicidality, and cataplexy. The pooled Phase-3 safety analysis was pre-specified and included data from the 3-month trials plus 3-month data from a 1-year safety trial of 40/30 mg.

Results: Of 493 patients who received suvorexant 20/15 mg and 767 who received placebo in the 3-month trials, 88% on suvorexant and 87% on placebo completed 3-months of treatment. Suvorexant improved PRO and PSG measures of sleep-maintenance (subjective-total-sleep-time, wakefulness-after-persistent-sleep-onset) and sleep-onset (subjective-time-to-sleep-onset, latency-to-persistent-sleep) compared to placebo at the earliest pre-specified timepoints (Week-1 for PRO and Night-1 for PSG measures) and Month-3 ($p < 0.01$), except for the PSG onset endpoint at Month-3 ($p = 0.06$). Suvorexant was generally well-tolerated with few discontinuations due to AEs (3.0% vs. 4.9% for placebo). The most frequent AE was somnolence (6.7% vs. 3.0% for placebo). No clinically important rebound-insomnia or withdrawal was observed. Suvorexant was well-tolerated during the 3-month extension.

Conclusion: Suvorexant 20/15 mg was effective and well-tolerated over 3 months in non-elderly and elderly patients with insomnia.

Support (If Any): Merck.

0581

COGNITIVE-BEHAVIORAL THERAPY FOR INSOMNIA IN OLDER ADULTS: IMPROVING SLEEP QUALITY REDUCES SLEEP DISCREPANCY

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Introduction: Subjective and objective estimates of sleep are often discordant, and insomnia patients typically under-report total sleep time (TST). Studies have demonstrated the efficacy of Cognitive-Behavioral Therapy for Insomnia (CBTi) in older adults, yet change in the subjective/objective discrepancy is rarely investigated. This study examined the impact and durability of CBTi on reducing sleep discrepancy in older adults, and tested whether changes in sleep quality were related to reductions in sleep discrepancy.

Methods: 159 older veterans (97% male, mean age 72.2 years) who met diagnostic criteria for insomnia of > 3 months duration were randomized to: 1) individual CBTi (iCBTi), 2) group CBTi (gCBTi), or 3) attention control. Assessments were conducted at baseline, post-treatment, 6-months, and 12-months follow-up. Sleep measures included: 1) sleep diary TST; 2) actigraphy TST; and 3) Pittsburgh Sleep Quality Index (PSQI) score. TST discrepancy was computed by subtracting actigraphy TST from sleep diary TST. Minutes of TST discrepancy in each intervention group were compared to controls using ANCOVA. A cross-lagged panel model was fit to the data to examine whether PSQI score was related to subsequent changes in sleep discrepancy.

Results: Compared to controls, participants randomized to iCBTi or gCBTi became more accurate in their perceptions of sleep at post-treatment (p 's < .05). Improvements persisted at 6-month (iCBTi = -1.8 minutes; gCBTi = -0.1 minutes; controls = -34.1 minutes; p 's < .05) and 12-month follow-up (gCBTi = 7.3 minutes; controls = -25.7 minutes; p 's < .05). Improvements in PSQI total scores at each study assessment predicted reduced sleep discrepancy at the next study assessment (e.g.,

lower 6-month PSQI predicted less discrepancy at 12-months, all paths $p < .05$).

Conclusion: CBTi reduces sleep discrepancy among older adults with insomnia. The reductions in sleep discrepancy were driven by prior improvements in sleep quality. Improving sleep quality appears to be a viable path to improving sleep perception and may explain the underlying effectiveness of CBTi.

Support (If Any): UCLA/NIA (5P30AG028748), NIH/NCATS/UCLA/CTSI (UL1TR000124), VA HSR&D (IIR:123532).

0582

PATTERNS AND PREDICTORS OF SLEEP QUALITY BEFORE, DURING, AND AFTER HOSPITALIZATION IN OLDER ADULTS: A LATENT CLASS ANALYSIS AND LOGISTIC REGRESSION APPROACH

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Introduction: Sleep quality changes in response to hospitalization, and is related to many important outcomes. The current study examined patterns of sleep quality before, during, and following hospitalization, evaluated predictors of patterns of sleep, and tested predictors of classification discordance between two commonly-suggested Pittsburgh Sleep Quality Index (PSQI) clinical cutoffs (> 5 or > 8).

Methods: Older adults ($n = 233$; mean age = 80.4 ± 7.1 years) undergoing inpatient post-acute rehabilitation at a VA medical center were recruited for participation in a prospective longitudinal study. Upon admission to inpatient post-acute rehabilitation patients completed the PSQI retrospectively regarding their sleep prior to hospitalization. They subsequently completed the PSQI at discharge, 3-, 6-, 9-, and 12-months post-discharge. Patient demographic and clinical characteristics were collected on admission and included: age, gender, ethnicity, reason for admission to rehabilitation, MMSE, depression, comorbidity burden, and pain.

Results: Using latent class analysis, we discovered that older adults can be classified into (1) 'consistently good sleepers' and (2) 'chronically poor sleepers' based on patterns of self-reported sleep quality across assessment time points (pre-illness through 1-year follow-up). This two-class pattern was maintained regardless of which PSQI cut-off score was used. Logistic regression analyses indicated that higher pain ($OR = .97$, $p = .018$) and higher depressive symptoms ($OR = .88$, $p = .005$) was consistently associated with lower likelihood of good sleep. Individuals with better cognitive status ($OR = 1.12$, $p = .009$) and more pain ($OR = 1.04$, $p = .017$) were more likely to change classifications from good to poor sleepers when the PSQI cutoff score was changed.

Conclusion: Over time and with hospitalization, patterns of consistently good or consistently poor sleep quality emerged. PSQI, when used in inpatient settings, may reflect chronic, rather than acute, sleep disturbance; especially with older patients with high pain or depressive symptoms. Alterations in the cutoffs employed to demarcate poor sleep may result in discordant clinical classifications.

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0583

UNTREATED MILD SLEEP DISORDERED BREATHING DOES NOT REDUCE THE EFFICACY OF COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA IN OLDER ADULTS

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Introduction: Sleep disordered breathing (SDB) and chronic insomnia are common in older adults, and several studies have demonstrated considerable comorbidity between these two conditions. Cognitive behavioral therapy for insomnia (CBTI) is the mainstay of treatment for chronic insomnia. SDB may be a predisposing and precipitating factor for insomnia and could potentially reduce the impact of CBTi. In a secondary data analysis, we sought to determine whether untreated mild SDB moderates the efficacy of CBTi in older adults.

Methods: In a randomized clinical trial, 159 older community-dwelling veterans (97% male, mean age 72.2 years) who met diagnostic criteria for insomnia and had an apnea-hypopnea index (AHI) < 20 (by WatchPAT) at baseline were randomized to CBTi (individual or group) versus attention-control. Participants completed sleep diaries and the Pittsburgh Sleep Quality Index (PSQI). Sleep outcomes were compared between CBTi and control groups at 6 months using ANCOVA, adjusted for baseline values. $AHI \geq 5$ versus $AHI < 5$ was included as an interaction term to evaluate whether it moderated the changes in sleep outcomes.

Results: At baseline, 75.5% of randomized patients had an $AHI \geq 5$ (mean AHI 9.4 [SD 5.3]) with no difference in AHI among groups ($p = .50$). CBTi improved sleep onset latency (SOL), total wake time at night (TWT), sleep efficiency (SE), and PSQI at 6 months compared to attention-control (all $p < .05$). $AHI \geq 5$ did not moderate the improvements in sleep associated with CBTi compared to $AHI < 5$ (SOL [$p = .07$], TWT [$p = .25$], SE [$p = .31$], or PSQI [$p = .46$]).

Conclusion: The presence of untreated mild SDB did not reduce CBTi efficacy. CBTi is beneficial for reducing sleep disturbance in older veterans with chronic insomnia, even in the presence of untreated mild SDB.

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0584

SHORTENED MEAN VALUE OF MULTIPLE SLEEP LATENCY TEST IS ASSOCIATED WITH INCREASED RISK OF HYPERTENSION IN PATIENTS WITH INSOMNIA

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Introduction: Patients with insomnia have been reported to have increased mean sleep latency (MSL) determined by multiple sleep latency test (MSLT) compared to normal controls. It has been demonstrated that short sleep duration is associated with the increased risk for hypertension. We examined the relationship between the prevalence of hypertension and MSLT in patients with insomnia.

Methods: 719 consecutive patients with insomnia were selected from Sleep Medicine Center, West China Hospital. All the patients completed an overnight polysomnographic (PSG) followed by a four-nap of MSLT. 552 subjects (42.01 ± 10.80 years old and 32.6% male) who fulfilled the criteria of $AHI < 5$ according to the PSG recording were used in this study. Insomnia was defined by a complaint of insomnia with a duration ≥ 6 months. Hypertension was defined based either on blood pressure measures or treatment. The MSL was classified into 3 categories: MSL $<$

8 min, $8 \leq \text{MSL} \leq 14$ min and $\text{MSL} > 14$ min. We controlled for age, sex, body mass index, diabetes, smoking, alcohol use, hypnotic usage, AHI, and PSG-recording total sleep time.

Results: Among all the patients, compared to the $\text{MSL} > 14$ min group, the odds ratio (OR) for hypertension was 2.38 (95% confidence interval [CI], 1.19-4.80, $p < 0.05$) in the $\text{MSL} < 8$ min group. We analyzed the effect of MSL on the prevalence of hypertension in different gender, respectively. The prevalence of hypertension in male and female patients was 15.6% and 18.3%, respectively ($p > 0.05$). In male patients, significantly higher risk of hypertension was in $\text{MSL} < 8$ min group (OR = 6.71, [2.12-22.22], $p = 0.001$) compared to $\text{MSL} > 14$ min group. However, in female patients, no significantly higher risk for hypertension was found in $\text{MSL} < 8$ min (OR = 1.03, [0.38-2.84], $p > 0.05$) group than in $\text{MSL} > 14$ min group.

Conclusion: The results suggest that shortened MSL in patients with insomnia may be associated with increased risk of hypertension, especially in the male patients.

0585

COMPARISON OF PSG SLEEP PARAMETERS, MICRO-STRUCTURE AND SPECTRAL PROFILES, BETWEEN PATIENTS WITH PRIMARY INSOMNIA AND GOOD SLEEPER CONTROLS USING A LARGE COMPILATION OF PSG RECORDINGS FROM THREE CLINICAL TRIALS

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Introduction: PSG macro/micro/spectral sleep measures were compared between patients with primary insomnia (PI) and good sleeper controls (GSC), and between/within these groups by age category and/or gender.

Methods: Comparisons between PI and GSC were made using PSG recordings from 882 PI patients and 815 GSC collected in the sleep laboratory on baseline nights of 3 clinical trials from one drug development program. Correlations between subjective and macro/micro/spectral sleep measures were also evaluated.

Results: Macrostructure: The PI cohort had longer latency to persistent sleep and wakefulness after sleep onset (WASO) than GSC (expected by design), and shorter sleep time overall and in each sleep stage (1, 2, 3 = SWS and REM). PI males had more WASO than PI females, PI non-elderly (age < 65) had less WASO than PI elderly. Females had less Stage 1 but more SWS than males in both cohorts. Stage transitions depended on sleep period, gender, and cohort. Microstructure: PI had more microarousals and fewer spindles and K-complexes than GSC. Females had more K-complexes and microarousals than males in both cohorts. PI females had more spindles than PI males. PI non-elderly had more spindles and K-complexes than PI elderly. Power Spectra: Differences between PI and GSC depended on age, gender, and sleep period. Power was higher for females than males regardless of age, frequency or cohort, and greater between genders than between cohorts. Subjective sleep: PI rated sleep worse than GSC, but there were no differences between genders or age categories within cohort. Correlations between subjective and macro/micro/spectral sleep measures were modest.

Conclusion: Analysis of a large EEG database revealed differences between PI and GSC that were dependent on age, gender, and sleep period, thus providing new information on sleep EEG in patients with primary insomnia.

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0586

SEPARATED INSOMNIA SEVERITY INDEX (ISI) DISTINGUISHES TWO PHENOTYPES OF SHIFT WORK DISORDER

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Introduction: Most patients meeting diagnostic criteria for SWD report insomnia. At the same time, 20-25% of the general population has insomnia. We hypothesize that a subgroup of SWD patients experience sleep difficulties primarily related to circadian misalignment, while another subgroup has an insomnia disorder per se precipitated by shift work.

Methods: 35 night workers participated in an overnight phase and MSLT assessment. Subjects with a history of insomnia or other sleep disorders prior to shift work were excluded. At 17:00, each subject completed an Epworth Sleepiness Scale (ESS) and two ISI scales: one specific to nighttime/off-shift sleep (ISI-N) and the other specific to daytime/on-shift sleep (ISI-D). Questions were identical to the standardized ISI, but instructions referred specifically to either daytime or nighttime sleep. 12 subjects with normal scores on all scales were classified as controls. 12 subjects with $\text{ESS} < 10$ and $\text{ISI-D} \geq 10$ were classified “alert insomniacs” (AI). 11 subjects with $\text{ISI-D} \geq 10$ and $\text{ESS} \geq 10$ were classified “sleepy insomniacs” (SI).

Results: AI showed elevated ISI scores with no significant difference between ISI-D (14.67 ± 3.17) and ISI-N (11.42 ± 6.93 , $p > .10$), indicating sleep disturbances even during nighttime sleep. In contrast, SI had significantly lower ISI-N scores (9.18 ± 6.73) than ISI-D scores (14.27 ± 4.81 , $p < .001$), indicating they sleep better at night. Nocturnal five-nap MSLT scores (22:30-06:30) were not significantly different between AI (7.8 ± 5.1) and controls (8.1 ± 3.4), but scores among the SI group were significantly lower (3.1 ± 3.0 , $p < .01$).

Conclusion: Use of a separated day/night ISI distinguishes between two insomnia phenotypes of SWD and may assist in the clinical management of the disorder. The insomnia/excessive sleepiness phenotype is associated with normal sleep during the night and pathological sleepiness, while the insomnia-only phenotype shows no difference in sleep disturbances between nocturnal and diurnal sleep. Patients with elevated scores on both scales may benefit from insomnia treatment in addition to phase alignment.

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0587

SPEED AND TRAJECTORY OF CHANGES OF INSOMNIA SYMPTOMS DURING ACUTE TREATMENT WITH COGNITIVE-BEHAVIORAL THERAPY, SINGLY AND COMBINED WITH MEDICATION

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Introduction: Most randomized clinical trials of cognitive behavioral therapy (CBT) and medication for insomnia typically focus on sleep changes occurring from baseline to post treatment (usually a 4- to 8-week period). However, there is little information about the trajectory of sleep changes over the course of short-term therapy. Information on the speed of recovery during initial treatment could be informative in studies comparing different combinations or sequences of medication and CBT.

This study examined the speed and trajectory of changes in sleep/wake parameters during short-term treatment of insomnia with CBT alone versus CBT combined with zolpidem, and explore whether early treatment response was predictive of post-treatment recovery status.

Methods: Participants were 160 adults with insomnia (mean age: 50.3 years; 97 women/63 men) who underwent a six-week course of CBT, singly or combined with 10-mg zolpidem nightly. The main dependent variables were sleep onset latency, wake after sleep onset, total sleep time, sleep efficiency, and sleep quality, derived from sleep diaries completed daily by patients throughout the course of treatment.

Results: Participants treated with CBT plus medication exhibited faster sleep improvements as evidenced during the first week of treatment compared to those receiving CBT alone. Optimal sleep improvement was reached on average after only one week for the combined treatment compared to two to three weeks for CBT alone. Early treatment response did not reliably predict post-treatment recovery status.

Conclusion: Adding medication to CBT produces faster sleep improvement relative to CBT alone. However, initial treatment response is not predictive of final response after the 6-week therapy. These findings suggest that medication may provide an early augmentation effect when added to CBT. Additional research is needed to examine mechanisms involved in this augmentation effect from the medication and its impact on long-term outcome.

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0588

WHO BENEFITS FROM ONLINE CBT FOR INSOMNIA? FACTORS ASSOCIATED WITH CHANGE IN SLEEP EFFICIENCY IN A LARGE ONLINE TREATMENT COHORT

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Introduction: Online CBT-I can be an effective treatment but it is not clear for whom this form of therapy is most effective. We tested baseline demographic, lifestyle and health indicators and programme engagement metrics as predictors of treatment outcome in users of Sleepio, a validated online CBT-I programme.

Methods: Analyses were based on routinely collected data from 809 programme users (61.3% F; mean age 47.5 ± 14.1 years) who met the Sleep Condition Indicator cut-off for DSM-5 defined Insomnia Disorder and completed all 6 sessions within 12 weeks. Treatment outcome was change in sleep efficiency (SE) from baseline to session six (S6). Baseline predictors were age, gender, working full-time, having a partner, self-reported mental and physical health, caffeine, smoking and exercise frequency. Objective programme engagement metrics included frequency of viewing educational content (library, recommended reading), online community involvement (views, posts), use of personalised message walls and therapeutic tools (thought checker, sleep diaries).

Results: Mean SE increased from 48.2% to 79.2% at S6 (mean 31.0 ± 23.8%). In linear regression, lower baseline SE predicted larger SE gains and explained 71.3% of the variance. In separate multivariable regression models, demographic measures explained 2.3% variance in SE change (model $p = 0.001$). Programme engagement metrics explained 4.4% ($p < 0.001$). Lifestyle and baseline health measures did not predict SE change (1.2% variance, $p = 0.077$). In a combined model adjusted for baseline SE, increased SE was associated with younger age, higher caffeine intake at baseline and specific engagement metrics: receiving personalised wallposts, recommended reading and sleep diaries completed per week; all $p < 0.05$.

Conclusion: Online CBT-I completion was associated with increased SE, especially for those with low baseline SE. Baseline demographic,

health and lifestyle characteristics did not strongly predict outcomes, suggesting that these factors are not barriers to effectiveness in those completing the course. Engagement with interactive support, educational and monitoring tools predicted positive outcomes even after adjustment for baseline SE.

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SLEEP-RELATED COGNITIVE AROUSAL ACROSS DIFFERENT INSOMNIA SUBGROUPS

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Introduction: While it is well known that psychophysiological insomnia is characterized by increased sleep effort, dysfunctional beliefs and attitudes towards sleep and heightened pre-sleep cognitive arousal, it is not clear how psychiatric comorbidity and history may impact sleep-related cognitions.

Methods: In the present study we compared four well-defined groups (Psychophysiological Insomnia [PI, $n = 51$], Insomnia with Remitted Recurrent Depression [I-RRD, $n = 45$], Insomnia comorbid with Major Depression [I-MD, $n = 33$], and Good Sleepers [GS, $n = 41$]) on the Glasgow Sleep Effort Scale (GSES), Dysfunctional Beliefs and Attitudes about Sleep scale (DBAS-total), Pre-Sleep Arousal Scale (PSAS-cognitive and somatic) and the Glasgow Content of Thoughts Inventory (GCTI).

Results: Groups were similar with respect to mean age (PI = 43.8 yrs; I-RRD = 43.2 yrs; I-MD = 42.1 yrs; GS = 40.2 yrs) and gender distribution (PI = 63%F; I-RRD = 71%F; I-MD = 67%F; GS = 66%F). The three insomnia patient groups evidenced similar ISI scores (PI = 17.4; I-RRD = 17.4; I-MD = 18.1), significantly differing from GS (2.3; p 's < .001). Scores on the GSES and PSAS-somatic subscale were similar across the three insomnia subgroups, being robustly different from controls ($p < .001$). Group comparisons for DBAS total, PSAS-cognitive subscale and GCTI again revealed that all groups differed from good sleepers (p 's < .001), but that both I-MD and I-RRD reported higher values relative to the PI group (p 's < .01).

Conclusion: All insomnia subgroups showed clear evidence of sleep-related cognitive arousal, sleep effort and dysfunctional beliefs and attitudes about sleep. Experiencing a current or recurrent (though presently remitted) depressive illness, in addition to persistent insomnia, was associated with enhanced pre-sleep cognitive arousal and thought content, as well as greater endorsement of dysfunctional sleep beliefs, relative to PI in isolation.

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PRELIMINARY EFFICACY OF E2006, A NOVEL DUAL OREXIN RECEPTOR ANTAGONIST FOR THE TREATMENT OF INSOMNIA DISORDER

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Introduction: E2006 is a dual orexin receptor antagonist (DORA) being developed for chronic treatment of insomnia. After evaluating safety, tolerability, and pharmacodynamic effects of single morning doses up to 200 mg in healthy volunteers, the preliminary efficacy of E2006 in the anticipated therapeutic dose range was tested in subjects with primary insomnia.

Methods: Following two 8-hr baseline polysomnography recordings (PSGs), eligible subjects ($n = 58$) received a single dose of E2006 (2.5 mg, 10 mg, or 25 mg), placebo, or zolpidem (10 mg) (included for assessing sensitivity of the protocol to changes in PSG sleep) before habitual bedtime. Postdose assessments included PSG, safety, and residual morning sleepiness. Change from baseline (average of 2 nights predose) to postdose in latency to persistent sleep (LPS), wakefulness after sleep onset (WASO) and sleep efficiency (SE) were evaluated.

Results: Twelve subjects were randomized to placebo and 11 subjects to zolpidem. For E2006, 13 subjects received 2.5 mg, 10 subjects received 10 mg, and 12 subjects received 25 mg. LPS changes from baseline (mean \pm SD, minutes) were: placebo; -7 ± 31 , 2.5 mg; -28 ± 45 , 10 mg; 29 ± 39 , 25 mg; -44 ± 36 , zolpidem; 33 ± 20 , respectively. WASO changes from baseline (minutes) were: placebo; -8 ± 27 , 2.5 mg; -29 ± 59 , 10 mg; -28 ± 54 , 25 mg; 46 ± 21 , zolpidem; 32 ± 31 , respectively. SE changes from baseline were: placebo 3 ± 10 , 2.5 mg; 11 ± 13 , 10 mg; 13 ± 7 , 25 mg; 18 ± 10 , zolpidem; 13 ± 9 , respectively. There were no clinically meaningful increases in residual sleepiness upon morning awakening in any E2006 dose group or zolpidem relative to placebo.

Conclusion: In subjects with insomnia, PSG sleep parameters were improved by single doses of E2006. Across the range of E2006 doses tested there were substantial reductions in LPS and WASO and increases in SE. The DORA E2006 warrants further study of its efficacy and safety in patients with insomnia.

Support (If Any): Supported by Eisai Inc.

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A RANDOMISED CONTROLLED TRIAL OF COGNITIVE BEHAVIOURAL THERAPY FOR INSOMNIA AS AN ADJUNCT THERAPY TO ANTIDEPRESSANTS FOR CO-MORBID INSOMNIA AND DEPRESSION.

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Introduction: Insomnia and depression are highly co-morbid disorders that share a complex bi-directional relationship. For optimal outcomes in the treatment of co-morbid depression and insomnia, the insomnia symptoms should be directly targeted alongside the depression. This study aimed to examine whether cognitive behavioural therapy for insomnia (CBT-I) can reduce the severity of insomnia and depression in individuals with co-morbid depression and insomnia when symptoms have not remitted with antidepressant treatment alone.

Methods: Participants were forty-one adults (18-64 years; 25F) with co-morbid depression and insomnia who had been treated with antidepressants for at least six weeks. Participants were randomised to four fortnightly sessions of either CBT-I or sleep education (self-help therapy). Insomnia (Insomnia Severity Index [ISI]) and depression (Beck Depression Inventory-II [BDI-II]) were examined at baseline, following each session and at 3-month follow-up. Quality and duration of sleep were assessed with actigraphy and self-report, in addition to assessments of anxiety, fatigue and daytime sleepiness.

Results: Compared to sleep education, the CBT-I treatment was associated with a greater reduction in BDI-II scores by 11.9 (95% confidence interval [CI] 6.6-17.3, $p < 0.001$) and in ISI scores by 6.6 (95% CI 3.0-10.2, $p = 0.001$) at the end of the 8-week treatment. Based on pre-established thresholds for insomnia and depression, 61.1% of CBT-I patients were in clinical remission at three-month follow-up compared to 5.6% of sleep education patients.

Conclusion: This study is the first randomised controlled trial of CBT-I for co-morbid insomnia and depression, with an active control treatment, to demonstrate substantial reductions in both insomnia and depression severity at post-treatment and follow-up. The results indicate that tar-

geting insomnia through CBT-I is efficacious for the treatment of co-morbid insomnia and depression, and can be considered an important adjunct therapy for patients with depression whose symptoms have not remitted with antidepressant treatment.

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TREATMENT OUTCOME IN LONG SLEEPERS WITH INSOMNIA FOLLOWING GROUP CBTI

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Introduction: Converging evidence suggests that insomnia with long self-reported sleep duration is clinically relevant. To our knowledge, no studies have evaluated whether traditional cognitive behavioral therapy for insomnia (CBTI) delivered to long sleepers with insomnia reduces (a) rates of insomnia and (b) sleep duration. We examined the success of CBTI, along with changes in sleep, for long sleepers with insomnia.

Methods: Participants were 320 patients, referred to a 7-session group CBTI treatment by a sleep specialist, whose sleep diaries indicated > 30 minutes sleep onset or wakefulness after sleep onset ≥ 3 times/week (quantitative criteria, QC). Individuals with total sleep time (TST) in the top 15% ($n = 47$, average TST = 8.0 ± 0.6 hours) were classified as long sleepers and compared to the remainder of the sample. Outcomes included diary-based weekly average TST and daytime sleepiness ratings, the Beck Depression Inventory (BDI), and remission (no longer meeting QC) following treatment.

Results: At baseline, long sleepers were younger than the remainder of the sample ($t(308) = 2.5$, $p < .01$) but no significant differences were observed for BDI, sex, or days of diary-reported sleep medications use. Significant differences were observed in pre-post change scores of TST ($t(318) = -5.4$, $p < 0.001$), whereby average TST decreased by 40 minutes in the long sleepers and increased by 13 minutes in the remainder of the sample. Despite reduced TST, long sleepers reported improvement in daytime sleepiness ($t(29) = 2.5$, $p < 0.02$). There were no differences in rates of insomnia remission between groups ($\chi^2 = .30$, ns). Results did not change with age as a covariate.

Conclusion: Following CBTI treatment, long sleepers with insomnia reported sleeping less but nonetheless noted improvement in daytime sleepiness. Groups did not differ in rate of insomnia remission. Thus CBT-I appears useful in treating insomnia among long sleepers. Future research should evaluate whether treatment improves psychiatric outcomes in this population.

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IS HYPERAROUSAL REFLECTED IN PSYCHOPHYSIOLOGICAL AND PARADOXICAL INSOMNIA SUFFERERS' REM SLEEP?

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Introduction: Hyperarousal is one of the core features of insomnia and it has been shown to be heightened in paradoxical insomnia (PARA-I) compared to psychophysiological insomnia (PSY-I). Hyperarousal has known impacts on NREM sleep, but its effect on REM sleep has been seldom studied. The objective of this study is to determine if PSY-I and PARA-I can be differentiated according to REM sleep variables, thus reflecting groups' respective hyperarousal level.

Methods: 47 Good Sleepers [GS; Mean age = $35.2 (9.0)$], 39 PSY-I [$40.3 (9.1)$] and 27 PARA-I [$39.3 (9.1)$] completed four consecutive PSG nights. The following variables of the macrostructure were mea-

sured on Nights 2 and 3: latency to REM (REML); duration of REM (REMD); and the number of periods of REM. For the microstructure, eye movements (EMs) were defined as a fluctuation ≥ 25 uV from baseline recorded EOG. The total number of EMs (TEMs) and a density score (DEMs: TEMs/minutes of REM) were computed. An arousal index was calculated by dividing the number of REM sleep awakenings and arousals by REMD.

Results: Repeated measures analyses revealed no main effect of groups for REML ($p \leq 0.9$), REMD ($p \leq 0.8$) and the periods of REM ($p \leq 0.6$). However, a main effect of nights was found for REML ($p \leq 0.005$), showing that REML was shorter on Night 3 compared to Night 2. Groups were also similar on TEMs ($p \leq 0.6$), DEMs ($p \leq 0.8$) and arousal index ($p \leq 0.1$).

Conclusion: It seems that REM sleep macrostructure and microstructure variables, as measured in the present project, do not reflect the different level of hyperarousal between groups of sleepers, suggesting that these variables have a limited grouping power. Either hyperarousal is more adequately reflected through other sleep variables or techniques (PSA, ERPs) or our current grouping procedure was not optimal. Identifying sleep characteristics to better distinguish insomnia types is still needed.

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CASE SERIES REVIEW OF PRE-POST CBT-I OUTCOMES

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Introduction: While there is a preponderance of clinical trial evidence that CBT-I is effective and that its clinical outcomes are moderate to substantial, little is known about the “real world” effects of the treatment. The prevailing assumption is that in-clinic effects are unlikely to exceed those of clinical trials given a variety of uncontrolled factors including: medical/psychiatric comorbidity, financial pressure to reduce the number or duration of sessions and/or the number of treatment components delivered, etc. The present study examined the efficacy of CBT-I utilizing a clinical sample.

Methods: Sixty patients (45% female; mean age = 53 ± 15.6 years) from the Philadelphia metropolitan area were evaluated and treated at the Penn Center for Sleep. None of the patients in the present analysis were using sleep medications. Intake interviews were conducted to establish ICSD diagnoses and clinical history. After a one-week baseline period, patients with insomnia were scheduled on a weekly basis for 4-8 sessions, during which five interventions were implemented: Sleep Restriction, Stimulus Control, Sleep Hygiene, Cognitive Therapy and Relapse Prevention. Sleep was monitored using sleep diaries for the duration of treatment.

Results: Baseline data were compared to 4 sessions of CBT-I (modal number of sessions) using paired t-tests. On average, patients that completed therapy were about 31% improved. This average corresponded to a 52% reduction in sleep latency (effect size = 0.70), 54% reduction in wake after sleep onset (effect size = 0.96), 27% reduction in number of awakenings (effect size 0.36), 4% increase in total sleep time (effect size = 0.16), and 19% increase in sleep efficiency (effect size = 1.23).

Conclusion: These findings suggest that “real world” CBT-I is effective. Analyses are ongoing and include: comparative efficacy, efficacy viz. number of sessions, outcomes with respect to medical/psychiatric comorbidities and hypnotic tapers (before vs. during CBT-I).

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ACCEPTANCE AND THE BEHAVIORAL CHANGES TO TREAT INSOMNIA (ABC-I): PILOT TESTING OF A NEW BEHAVIORAL TREATMENT FOR INSOMNIA IN WOMEN VETERANS

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Introduction: Insomnia is common and often severe among women Veterans, yet there are significant challenges to adherence to cognitive-behavioral therapy for insomnia (CBT-I) recommendations due to high rates of psychiatric comorbidities and psychosocial factors. Women Veterans are likely to discontinue psychological treatments in general, and interventions that encourage adherence and retention are needed. In preparation for a larger randomized trial, we pilot tested a behavioral insomnia treatment, “The ABC of Insomnia” (ABC-I) to explore whether this treatment would improve sleep quality among women Veterans.

Methods: 11 women Veterans with insomnia participated (mean (SD) age = 56.4 (13.3) years). 3 women were excluded for sleep apnea (based on AHI > 15 using WatchPAT home sleep test, and 3 based on unstable comorbid conditions). Women were not excluded for stable comorbidities. 5 individuals began treatment and 4 completed pre- and post-treatment evaluations, including the PSQI, ISI and a daily sleep diary to compute weekly sleep efficiency (D-SE). Participants received the 5-session manualized ABC-I program from a behavioral sleep medicine psychologist. The ABC-I incorporates principles, metaphors and experiential exercises based on Acceptance and Commitment Therapy (ACT; Values, Committed Action, Acceptance, Mindfulness, Defusion, Self as Context) with components of traditional behavioral insomnia treatment (Sleep Education, Sleep Restriction, Stimulus Control). Paired t-tests were used to examine differences between pre- and post-treatment.

Results: PSQI scores improved an average of 4.5 points ($t = 2.33$, $p = .10$), ISI scores improved an average of 9.75 points ($t = 2.22$; $p = .11$), D-SE improved an average of 12% ($t = 5.14$, $p = .01$). All participants showed changes in the therapeutic direction from pre- to post-treatment.

Conclusion: The ABC-I program resulted in significant improvements in sleep from pre- to post-treatment among women veterans with insomnia. Studies comparing this approach to traditional CBT-I are needed to evaluate treatment retention and adherence outcomes.

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0596

PSYCHOSOCIAL PROBLEMS ARE GREATER AMONG ALCOHOLICS WHO COMPLAIN OF INSOMNIA

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Introduction: Psychosocial problems are known consequences of both pathological alcohol consumption and insomnia (which also frequently co-occur). It is unknown, though, whether an interaction exists, such that psychosocial problems among alcoholics are worse in the context of insomnia. Since psychosocial problems may increase treatment-related recidivism, if problems are worse with insomnia, this would strengthen the role of insomnia as a modifiable risk factor in alcoholism. The present study evaluates whether insomnia in alcoholics is associated with more psychosocial problems as compared to alcoholics without insomnia.

Methods: Alcoholics (N = 123) were evaluated at baseline as part of a clinical trial using the following instruments: Short Index of Problems (SIP: psychosocial consequences of alcoholism); Addiction Severity Index (ASI: employment, social and legal problems); 3) Insomnia Severity Index (ISI: insomnia symptoms); Time Line Follow Back (TLFB: alcohol consumption). ANOVA and linear regression analyses evaluated the relationships between insomnia and psychosocial problems.

Results: The mean age was 44 (SD = 10) years and 83% were males. The rates of insomnia included the following: 25% with no insomnia; 29% with mild insomnia; and 46% with moderate-severe insomnia. The SIP sub-scale scores approximated the 5th decile in relation to normative data. Those with moderate-severe insomnia (versus without insomnia and mild insomnia) reported significantly greater problems on all SIP-recent sub-scales (social, intrapersonal, interpersonal, physical and impulse control; all $p < 0.005$), 4 SIP-lifetime sub-scales (intrapersonal, interpersonal, physical and impulse control; all $p < 0.02$); and the ASI (conflicts with friends/family, $p < 0.03$). There were no differences in the alcohol consumption variables across the insomnia groups. Finally, ISI score predicted SIP-recent, and SIP-lifetime total scale scores in regression analyses.

Conclusion: Alcoholics with insomnia had more social conflicts and higher intensities of both recent and lifetime psychosocial problems. This may explain some of the unique challenges faced by this population. Future studies should clarify the relationship between insomnia and psychosocial problems in alcoholics, employing treatments for insomnia or for alcoholism.

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0597

MEDIATORS OF COGNITIVE BEHAVIOURAL THERAPY FOR INSOMNIA IN CO-MORBID INSOMNIA AND DEPRESSION

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Introduction: Cognitive behavioural therapy for insomnia (CBT-I) is an effective treatment for insomnia. Recent evidence suggests that CBT-I also improves depression. The current study examined potential mediators of CBT-I to determine which aspects of the treatment are having the largest influence on insomnia and depression outcome, immediately following treatment and at 3-month follow-up.

Methods: Forty-one participants (aged 18-65 years) with co-morbid depression and insomnia were randomized to receive four sessions of either CBT-I or sleep education (self-help) over 8 weeks. Proposed mediators of CBT-I were examined to determine whether they significantly accounted for the relationships between treatment group and improvements in insomnia (Insomnia Severity Index) and depression (Beck Depression Inventory-II).

Results: At post-treatment, the larger depression improvements through CBT-I were associated with reduced stress, improved sleep hygiene, and other therapeutic effects of CBT-I. In contrast, the larger insomnia improvements were mediated by reduced dysfunctional beliefs about sleep. At 3-month follow-up, the larger depression improvements in the CBT-I group were mediated by reduced stress and dysfunctional beliefs about sleep. Reduced dysfunctional beliefs about sleep and other therapeutic effects of CBT-I explained the greater insomnia improvements at follow-up.

Conclusion: This study is the first to specifically identify the mediators of CBT-I treatment for individuals with co-morbid insomnia and depression. Improvements in hyper-arousal and behaviour around sleep

are required through CBT-I for short-term reductions in depression severity, whereas sleep-related cognitive changes are required for short-term insomnia improvement and longer-term depression and insomnia improvement.

0598

ARE INHIBITION DIFFICULTIES IN INSOMNIA ASSOCIATED WITH SUBJECTIVE SLEEP PERCEPTION?

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Introduction: Insomnia sufferers (INS) are cortically hyperaroused, which leads to enhanced information processing and can be measured with event-related potentials (ERP). During sleep, cortical arousability decreases while inhibition of information processing increases. Actual ERP literature shows INS might present difficulties with both of these processes when compared to good sleepers (GS). Not only are they more aroused, but they also invest more energy into inhibiting information processing. Our objective is to investigate if inhibition deficits are linked to the perception of sleep among INS.

Methods: 32 GS (37.1 ± 8.6 years) and 32 INS (38.5 ± 6.9) underwent 4 consecutive nights of PSG recordings. ERPs were recorded on night 4 using an oddball paradigm. N1, P2 and N350 components were recorded during early stage 2 (2E), late stage 2 (2L) and slow wave (SWS) sleep at Cz. Spearman and Pearson correlations were computed between subjective SOL, WASO, SE and ERP amplitudes.

Results: For GS, subjective sleep parameters were only associated with N1 amplitude for deviant tones during 2L (SE: $r_s = 0.443$, $p \leq 0.05$ and SOL: $r_s = -0.506$, $p \leq 0.01$). For INS, N1 amplitude for deviant tones during SWS was associated with SE ($r_s = -0.535$, $p \leq 0.05$), SOL ($r_s = 0.453$, $p \leq 0.05$) and WASO ($r_s = 0.465$, $p \leq 0.05$). Moreover, N350 amplitude during 2E was associated with SOL ($r_2 = -0.401$, $p \leq 0.05$) for standard tones. It was also associated with SE ($r_s = 0.579$, $p \leq 0.01$) and WASO for deviant tones ($r_s = -0.519$, $p \leq 0.05$) during 2L.

Conclusion: For both groups, less cortical arousal was associated with a better subjective experience of sleep. However, for INS, a better subjective sleep experience was also associated with less energy being invested into inhibiting information processing. This suggests inhibition alterations during sleep might result in INS being more conscious of the surrounding stimulation which in turn could influence their subjective sleep experience.

0599

SHORT- AND LONG-TERM STABILITY OF SLEEP DURATION IN INSOMNIACS AND HEALTHY CONTROLS

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Introduction: Due to the expense of in-laboratory polysomnography (PSG), sleep researchers often opt to record participants for a single night only. However, night-to-night variability raises questions of whether a single night is valid and represents the person's habitual sleep patterns. Our aim was to evaluate sleep stability over consecutive nights in insomniacs versus healthy controls, and across several years in a general population sample.

Methods: Insomniacs (n = 151, 51.7% male; 36.6 ± 13.4 y) were recorded over four consecutive nights, while controls (n = 150, 56.7% male; 36.0 ± 14.6 y) were recorded over three consecutive nights. An additional 95 men (51.1 ± 11.0 y) from the Penn State Adult Cohort were recorded twice, with 2.6 y between visits. All individuals underwent a

fixed 8-hour PSG recording. Stability of total sleep time (TST) across nights was assessed by intraclass correlation (ICC). Individuals were categorized as “normal” or “short” sleepers based on median TST each night, and persistence of their first-night classification on subsequent nights was assessed.

Results: Coefficients of stability for TST were “substantial” in the short-term across all combinations of consecutive nights in insomniacs (ICC range = 0.55-0.75) and controls (ICC range 0.65-0.75), and in the long-term in a general population sample (ICC = 0.67). Among insomniacs, the majority of individuals who had “short” sleep during Night 1 were also short sleepers on subsequent Nights 2-4 (76.0%); the same pattern was true for short-sleeper controls on Nights 2-3 (71.4%) and of a general population across the long-term (73.5%).

Conclusion: Sleep duration is relatively stable across subsequent nights in insomniacs and controls, and across several years in a general population sample. One night of in-laboratory PSG may provide an accurate relative ranking of sleep classification for individuals within controls and within insomniacs. Future studies should examine whether PSG studies can be replaced with more convenient, cost-effective methods.

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0600

YOGA NIDRA: AN INNOVATIVE APPROACH FOR MANAGEMENT OF CHRONIC INSOMNIA

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Introduction: Chronic insomnia is a prevalent condition and non pharmacological treatment is beneficial in these patients. Yoga nidra according to ancient scriptures is referred as ‘dynamic sleep’ which is practised by sages. The relative ease with which it can be practised has made it an acceptable therapeutic option for many diseases. The objective of the study was to find out the role of yoga nidra in chronic insomnia patients.

Methods: Chronic insomnia patients (n = 9) were taught yoga nidra using standardised method. The patients were administered yoga nidra under supervision for five subsequent days, each session lasting forty minutes, following which they practised daily at home. Patients were reviewed fortnightly. Pittsburgh sleep quality index, insomnia severity scale, Epworth sleepiness scale, pre-sleep arousal scale and their sleep parameters using two weeks sleep diary was collected at baseline and after one month of start of yoga nidra. All patients underwent baseline overnight polysomnography (Somnomedics, Germany) and eight patients also underwent polysomnography after one month of start of yoga nidra. Polysomnography was scored using standard criteria. Mean sleep onset latency, total sleep time, wake after sleep onset and sleep quality from sleep diary and, total sleep time, sleep efficiency, sleep onset latency, REM onset latency, wake after sleep onset and durations of wake, stage N1, N2, N3 and REM from polysomnography was analysed.

Results: Practising yoga nidra for one month caused decrease in sleep onset latency and increase in sleep quality significantly in sleep diary ($p < 0.05$). In polysomnography, there was a significant increase in sleep efficiency and N3 duration ($p < 0.05$) with significant decrease in wake duration ($p < 0.05$). Questionnaires showed significant improvement in Pittsburgh sleep quality index, insomnia severity index and pre-sleep arousal scores ($p < 0.05$).

Conclusion: Yoga nidra can play an important role in management of chronic insomnia patients.

0601

A NEW METHOD TO QUANTIFY THE DAYTIME IMPACT OF INSOMNIA ON A DAY-TO-DAY BASIS: THE MADRID INSOMNIA IMPACT SUBJECTIVE ASSESSMENT SCALE

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Introduction: The diagnosis of insomnia disorder requires that the loss of adequate nighttime sleep produce a significant daytime impact. Likewise one of the main objectives of the cognitive-behavioral therapy for insomnia is to regain daytime wellbeing and functionality and not only nighttime sleep quality and quantity. Currently there is no method available in clinical practice that specifically quantifies the subjective daytime impact of insomnia in several areas of functioning and on a day-to-day basis. Such method would be of great help in the diagnosis of insomnia disorder and especially in the monitoring of the clinical response during treatment.

Methods: We have devised a simple method aimed at assessing the daytime impact of insomnia that we have called Madrid Insomnia Impact Subjective Assessment (MIISA). It requires one minute a day from the patient to complete and provides a numeric and graphic evolution of the patient’s daytime performance. It assesses several areas of functionality (alertness, energy, physical state, intellectual performance, work performance, relationships, and worries about insomnia), through the assignment by the patient of a number from -4 (extremely bad), to +1 (even better than usual), being 0 not having any complaints in that area that day. We have used the MIISA in a clinical group of patients with insomnia disorder and no medical or psychiatric comorbidities to test for its clinical utility during diagnose and treatment. We have compared values of the MIISA with those of sleep diaries, as well as with the Insomnia Severity Index (ISI), the Pittsburgh Sleep Quality Index (PSQI), and with the psychomotor vigilance test (PVT), an objective measure of alertness.

Results: The study is at the moment in its early stages. Preliminary results suggest that MIISA is correlated with several subjective measures of nighttime sleep performance as assessed by sleep diaries. In our clinical experience the MIISA gives a good estimation of the subjective daytime functioning in patients with insomnia and is sensitive to change during treatment.

Conclusion: The MIISA Scale is an easy-to-use and useful clinical tool for the diagnosis and monitorization of treatment of insomnia.

0602

SEXSOMNIA AND SLEEP FORENSICS: THE INTERFACE BETWEEN SLEEP-RELATED ABNORMAL SEXUAL BEHAVIORS AND THE LAWCramer Bornemann MA¹, Mahowald MW^{2,3}, Schenck CH^{4,5}¹Sleep Medicine Care Services, HealthEast Care Systems of Minnesota, Saint Paul, MN, USA, ²Department of Neurology, University of Minnesota Medical School, Minneapolis, MN, USA, ³Stanford University, Palo Alto, CA, USA, ⁴Department of Psychiatry, University of Minnesota Medical School, Minneapolis, MN, USA, ⁵Hennepin County Medical Center, Minneapolis, MN, USA

Introduction: Sleep forensics is an investigative field often associated with the sleepwalking defense in cases of homicide. For 7 years (8/1/06 to 6/1/13), a sleep forensics team comprised of 3 sleep medicine physicians known for their contributions to the field of parasomnias were consulted by the legal community to review criminal cases involving a potential sleep disorder (total # cases = 262). As anticipated, parasomnias were the most prevalent sleep disorder subtype implicated (N = 131). Further analysis within this subtype reveals that sleep-related abnormal sexual behavior, often referred to as Sexsomnia, was the most common condition implicated (N = 103).

Methods: Sexsomnia demographics reveal gender of the perpetrator to be predominantly male (N = 102) with an age range of 18-55 years (N = 102) while gender of the victim to be female (N = 99) with an age range of 3-17 years (N = 73). 86% of the victims knew the perpetrator (N = 89) as a family member, significant other, or friend.

Results: Sexual behavior was divided into 3 subtypes: i) Inappropriate touch- in isolation or combined on breasts/genital region (N = 65), ii) Sexual contact- in isolation or combined with oral/genital/anal (N = 37), and iii) Indecent exposure (N = 1). Proximity between victim and perpetrator during the course of the behavior reveals it was: i) confined to bed (N = 47), ii) confined to bedroom (N = 19), or iii) began outside of bedroom (N = 37).

Conclusion: This data is the first methodical analysis of parasomnias in a formal medico-legal arena and underscores the forensic implications of violent parasomnias which are common from the perspective of sexual assault. Analysis from such forensics data provides further insight into sleep-related abnormal sexual behaviors to enhance public safety and provides an important avenue to improve the legal system's understanding, or lack thereof, of these sleep-related conditions.

0603

DIAGNOSTIC THRESHOLDS FOR QUANTITATIVE REM SLEEP PHASIC BURST DURATION, MUSCLE DENSITIES, AND REM ATONIA INDEX IN REM SLEEP BEHAVIOR DISORDER WITH AND WITHOUT COMORBID OBSTRUCTIVE SLEEP APNEA

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Introduction: Previous REM sleep without atonia (RSWA) studies have excluded patients with sleep apnea, potentially limiting application to clinical REM sleep behavior disorder (RBD) populations. We aimed to determine whether phasic burst duration and conventional RSWA methods could accurately diagnose RBD patients with co-morbid OSA.

Methods: We analyzed RSWA phasic burst durations, phasic, "any" and tonic densities by both 3-second mini-epoch and 30-second (AASM rules) epoch scoring approaches, as well as automated REM atonia index (RAI) in Parkinson disease (PD)-RBD and matched controls with OSA. Group RSWA metrics were then analyzed and regression models fit to explore associations with clinical variables, with receiver opera-

tor characteristic (ROC) curves determining the best diagnostic cut-off thresholds for RBD diagnosis.

Results: All mean RSWA phasic burst durations and densities were higher in PD-RBD patients than controls ($p < 0.0001$), and RSWA associations with PD-RBD remained significant when adjusting for age, gender, and REM AHI ($p < 0.0001$). RSWA density (phasic, "any") cut-offs for 3-second mini-epoch scorings were submental (SM) (15.5%, 21.6%), anterior tibialis (AT) (30.2%, 30.2%), and combined SM/AT (37.9%, 43.4%). Diagnostic cutoffs for 30-second epochs (AASM criteria) were SM 2.8%, AT 11.3%, and combined SM/AT 34.7%. Tonic density cutoff of 1.2% was 100% sensitive and specific, while RAI (SM) cutoff was 0.88. Phasic muscle burst duration cutoffs were: SM (0.65) and AT (0.79) seconds. Combining phasic burst durations with RSWA densities improved sensitivity and specificity of RBD diagnosis.

Conclusion: This study provides evidence for RSWA diagnostic thresholds applicable in PD-RBD patient populations with co-morbid OSA using conventional EMG lead placements during split-night polysomnograms, with suggested cut-offs for 3-second mini-epoch scorings as follows: combined SM/AT muscles 43.4%, RAI 0.88, and phasic muscle burst durations SM 0.65 and AT 0.79 seconds. Diagnostic cutoffs for 30-second epochs (AASM criteria) were SM 2.8%, AT 11.3%, and combined SM/AT 34.7%. Future studies with similar methods in idiopathic RBD patients with co-morbid OSA are planned.

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0604

QUANTITATIVE ANALYSES OF REM SLEEP WITHOUT ATONIA IN CHILDREN AND ADOLESCENTS WITH REM SLEEP BEHAVIOR DISORDER

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Introduction: Idiopathic REM sleep behavior disorder (RBD) represents the initial clinical presentation of synucleinopathy neurodegeneration in older adults. However, the clinical significance of REM sleep without atonia (RSWA) and overt RBD in children and adolescents remains unclear, and the lower age bound for occurrence of RSWA is not well established. We aimed to quantitatively analyze RSWA in pediatric patients with clinical RBD.

Methods: We manually scored RSWA and performed automated submental REM atonia index (RAI) according to established methods in 9 clinically diagnosed RBD patients with dream enactment behavior history and 9 age-gender matched controls with primary snoring who underwent polysomnography (PSG) at Mayo Clinic between 2008-2013. We then compared phasic, tonic, and "any" muscle activity percentage densities, phasic muscle activity burst durations, and RAI for the submental (SM), anterior tibialis (AT), and for both muscles combined, between groups with non-parametric statistical tests.

Results: Each group had 6 boys and a mean age of 9 years. RAI was significantly lower in RBD patients, indicating a lower proportion of atonia and increased REM sleep muscle tone in RBD patients compared to controls (0.82 vs. 0.93, $p = 0.0005$). Combined SM/AT mean "any" (29.4% vs. 12.9%, $p = 0.012$) and phasic (28.5% vs. 12.9%, $p = 0.012$) densities were significantly higher in RBD cases than controls. RBD patient tonic densities trended toward a higher percentage than controls (1.2% vs. 0.05%, $p = 0.08$). SM "any" density was also higher in RBD

than controls (17.4% vs. 0.08%, $p = 0.038$), although AT “any” and phasic densities (both 14.4% vs. 5.3%, $p = 0.12$) were similar between groups. SM (0.71 vs. 0.62 seconds, $p = 0.79$) and AT (0.70 vs. 0.67 seconds, $p = 0.53$) durations were also similar between groups.

Conclusion: Similar to adults, children and adolescents with RBD have abnormal RSWA metrics, which are driven by higher phasic densities in the submentalis muscle. However, unlike adults, there were no significant differences in phasic muscle burst durations, suggesting that different mechanisms may underlie RSWA and RBD through the lifespan. Additional studies in a larger cohort of children will be necessary to further clarify possible differences in the pathophysiology of RSWA and RBD in the pediatric population.

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0605

A NOVEL NON-REM AND REM PARASOMNIA WITH SLEEP BREATHING DISORDER ASSOCIATED WITH ANTIBODIES AGAINST IGLON5

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Introduction: We describe the clinical video-polysomnographic (PSG) and neuropathological features of an unrecognized disorder characterized by prominent sleep symptoms and antibodies against a novel cell-surface protein named IgLON5.

Methods: Eight patients with antibodies showing a similar reactivity with neuropil of rat brain were identified. Five patients underwent PSG and two had brain postmortem examination. Immunoprecipitation and mass spectrometry were used to identify the antigen.

Results: All eight patients (five women; age range: 52 to 76 years, median: 59 years) had abnormal sleep movements and behaviors along with obstructive sleep apnea. Five patients underwent video-PSG showing undifferentiated NREM sleep and poorly structured N2 sleep with frequent simple movements and finalistic-purposeful behaviors and REM sleep behavior disorder. Normalization of NREM sleep characteristically occurred in the last part of the night. All five patients had stridor during sleep and obstructive sleep apnea. Six patients had a protracted clinical course (median: 5 years, range 2-12 years); in four the sleep disorder was the initial and most prominent symptom, and in the other two it was preceded by progressive gait instability, and subsequently accompanied by dysarthria, dysphagia, and chorea. Two patients had a rapid presentation of the sleep disorder (2 and 6 months) along with severe disequilibrium, dysarthria, dysphagia, and central hypoventilation. Sudden death occurred in six patients (median time from symptom onset: 3.5 years, range 0.2-12 years); Neuropathological examination showed a novel neuronal tauopathy mainly involving the tegmentum of the brainstem and hypothalamus. All patients had serum and CSF antibodies against an extracellular epitope of IgLON5, a cell-adhesion molecule involved in synaptogenesis.

Conclusion: IgLON5 antibodies identify a novel tauopathy that associates with a sleep disorder characterized by NREM and REM parasomnia and sleep disordered breathing.

0606

HEALTH-RELATED QUALITY OF LIFE IN IDIOPATHIC AND SYMPTOMATIC REM SLEEP BEHAVIOR DISORDER

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Introduction: Idiopathic REM Sleep Behavior Disorder (iRBD) is characterized by potentially injurious dream enactment behaviors, frequent sleep and mood disturbances, and subtle cognitive, motor, and autonomic manifestations of synucleinopathy neurodegeneration, factors which could affect health-related quality of life (QOL). To our knowledge no previous research has assessed QOL in iRBD. We hypothesized that iRBD patients would demonstrate QOL impairments.

Methods: Patients with iRBD, symptomatic RBD with mild cognitive impairment (sRBD+MCI), and age-gender-educationally matched control subjects received QOL assessment with the Medical Outcomes Survey SF-36, as well as the Adult ADHD Scale, Epworth Sleepiness Scale (ESS), Pittsburgh Sleep Quality Index (PSQI), NeuroPsychiatric Questionnaire (NPQ), Zung Self-Rating Depression Scale (ZDS), and the Alertness Rating Scale (ARS). Group differences were compared with non-parametric tests, and multiple linear regression analyses explored associations between QOL domains and predictor measures.

Results: Twenty-three iRBD, 10 sRBD+MCI, and 23 controls participated. iRBD patients reported more frequent hyperlipidemia ($p = 0.02$), mood problems ($p = 0.02$), constitutional problems ($p < 0.0001$), and hypertension ($p = 0.08$). Co-morbid sleep apnea was seen in 86% of iRBD and 80% of sRBD+MCI patients ($p < 0.0001$). MOS SF-36 survey responses showed significantly reduced QOL scores in iRBD and sRBD vs. controls on 6/8 SF-36 subdomains (all $p < 0.05$). Both RBD groups reported significantly lower alertness (ARS), greater sleepiness (ESS), and worse sleep quality (PSQI) than controls (all $p < 0.05$). iRBD and sRBD patients also demonstrated significant impairments in most NPQ domains ($p < 0.05$), and highly probable ADHD ($> 23/72$) was also more common in iRBD than controls (27.6 vs. 20.3, $p = 0.03$). ZDS scores were higher in iRBD and sRBD than in controls (both $p < 0.002$). Multivariable regression controlling for age, gender, and apnea hypopnea index (AHI) found that ZDS score was independently predictive of the General Health, Social Function, Emotional Well Being, and Energy/Fatigue SF-36 subdomains ($F = 3.24$, $p = 0.029$).

Conclusion: Patients with iRBD reported significant QOL impairments compared to controls that appeared largely attributable to depressive symptoms, suggesting that physicians must be vigilant to recognize and appropriately address co-morbid depression in RBD patients to maximize their QOL, in addition to usual care goals of treating injurious dream enacting behaviors and counselling about synucleinopathy risk.

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0607

AGOMELATINE IN IDIOPATHIC REM SLEEP BEHAVIOR DISORDER

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Introduction: Clonazepam and melatonin are the two most commonly used agents in the treatment of REM sleep behavior disorder (RBD). However, clonazepam may have different side effects and melatonin seems to work only in a portion of patients, at high doses, or in association with clonazepam (Schenck, 2013). The mechanisms for the positive effect of melatonin is still unknown. Agomelatine, a melatonin receptor agonist, is a novel antidepressant with 5-HT_{2c} antagonist properties. A preliminary study on 3 patients indicated that agomelatine may improve RBD symptoms (Bonakis, 2012)

Methods: We studied by videoPSG 10 drug-naïve patients with iRBD, mean age 64.2 ± 9.9 years, before and after (2.2 ± 0.4 months) agomelatine 25 mg at bedtime treatment. Clinical assessment was done by means of the CGI at baseline and at follow-up, and the REM sleep behavior disorder severity scale (RBDSS, Sixel-Doring 2011) evaluating motor events and vocalizations during the videoPSG. PSG analysis included sleep structure and REM sleep atonia index (Ferri, 2010)

Results: None of the patients reported side effects. VideoPSG analysis (RBDSS scale for motor events 1.67 ± 0.7 vs. 1.89 ± 0.60 and for vocalizations 0.78 ± 0.44 vs. 1.00 ± 0.2) showed no significant difference before and after treatment. CGI before and after treatment was also similar (3.78 ± 0.83 vs. 3.55 ± 0.72, n.s.). Sleep parameters showed no significant difference between the two recording nights. There was a trend toward a decrease in REM sleep percentage (21.5 ± 5.7 vs. 18.2 ± 6.5) and an increase in PLMS index (20.1 ± 16.7 vs. 26.1 ± 23.1). REM sleep atonia index was consistently below 0.8 indicating an altered EMG atonia during REM sleep but without significant difference between the two PSG analyses (0.78 vs. 0.77). From a clinical point of view, we had only 2 patients who reported an improvement in episodes during the night.

Conclusion: In our short-term study, we did not find significant effects of agomelatine on sleep structure and video-analysis in patients with idiopathic RBD. The clinical impression resulted not different as a group, although 2 patients reported an improvement in the frequency and intensity of nocturnal episodes. However, we had no modifications of sleep parameters and of total sleep time or sleep efficiency indicating that agomelatine may be a safe choice as an antidepressant drug in patients where other antidepressants (i.e. pure serotonergic agents) may have deleterious effects on sleep and REM behavior episodes.

0608

VALIDATION OF AN INTEGRATED SOFTWARE FOR THE DETECTION OF REM SLEEP BEHAVIOR DISORDER

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Introduction: The polysomnographic hallmark of REM sleep behavior disorder (RBD) is REM sleep without atonia (RWA). To overcome the disadvantages of manual RWA scoring, which is time consuming but essential for the accurate diagnosis of RBD, we aimed to validate a software specifically developed and integrated with polysomnography for RWA detection against the gold standard of manual RWA quantification.

Methods: Polysomnographic recordings of 20 RBD patients and 60 healthy volunteers were analyzed. Motor activity during REM sleep was quantified manually and computer-assisted (with and without artifact detection) according to SINBAR criteria for the mentalis (“any”, phasic, tonic electromyographic (EMG) activity) and the flexor digitorum superficialis (FDS) muscle (phasic EMG activity).

Results: Computer-derived indices (with and without artifact correction) for “any”, phasic, tonic mentalis EMG activity, phasic FDS EMG activity, and the SINBAR index (“any” mentalis + phasic FDS) correlated well with the manually-derived indices (all Spearman rhos 0.66-0.98). In contrast to computerized scoring alone, computerized scoring plus manual artifact correction (median duration 5.4 minutes) led to a significant reduction of false positives for “any” mentalis (40%), phasic mentalis (40.6%), and the SINBAR index (41.2%). Quantification of tonic mentalis and phasic FDS EMG activity was not influenced by artifact correction.

Conclusion: The computer algorithm used here appears to be a promising tool for RWA quantification and detection of RBD both in research and clinical routine, particularly when combined with manual artifact correction.

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0609

IMPACT OF COMORBID OBSTRUCTIVE SLEEP APNEA IN REM SLEEP BEHAVIOR DISORDER ON THE SLEEP-RELATED INJURY AND DIAGNOSTIC DELAY

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Introduction: Although OSA can mimic REM sleep behavior disorder (RBD), it is unclear whether the comorbid OSA has an impact on the sleep-related injury and diagnosis of RBD.

Methods: We retrospectively collected the consecutive 53 patients who fulfilled RBD diagnostic criteria of ICSD-2. We investigated the sleep history and polysomnographic (PSG) findings between RBD and comorbid OSA group.

Results: Among 53 RBD patients, 71% (n = 38) were male and the median age was 65 (interquartile range: 57.5, 71.5). The median onset age was 61 (53, 67.5) and the median interval from RBD symptom-onset to diagnosis was 3 (1, 7.5). Twenty-three patients (43.4%) could be diagnosed as OSA, and 83% (n = 19) were male. In RBD with OSA group, the median AHI was 16.5 (10.2, 27). Thirteen had a history of sleep-related injurious behaviors; self-injury in 8, bed-partner injury 12, both 7. During PSG, thirteen showed evident dream acting out (Nine had a sleep-related injury). In RBD only group (n = 30), 10 had a history of sleep-related injurious behaviors; self-injury in 10, bed-partner injury 3, both 3. In PSG, fifteen showed dream acting out (Ten had a sleep-related injury). There was no significant difference in overall injurious behaviors (self-injury or bed-partner injury) between RBD and RBD with OSA group (p = 0.091). However, bed-partner injury was more prevalent in RBD with OSA group (p = 0.001). There was no difference in the diagnostic delay between male and female (4.55 ± 4.397 vs. 4.33 ± 3.716, p = 0.874) and also between RBD and RBD with OSA group (4.33 ± 4.405 vs. 4.7 ± 3.959, p = 0.913). RBD with OSA group showed significantly increased N1% (p = 0.05) and arousal index (p = 0.02).

Conclusion: The comorbid OSA did not affect the overall history of sleep related-injurious behaviors and diagnostic delay. However, the history of bed-partner injury may be more prevalent in the comorbid OSA group.

0610

POSITRON EMISSION TOMOGRAPHY WITH FMT IN PATIENTS WITH IDIOPATHIC RAPID EYE MOVEMENT SLEEP BEHAVIOR DISORDER

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Introduction: It has become clear that Parkinson's disease (PD) can have a premotor stage such as idiopathic REM sleep behavior disorder (IRBD). Imaging technologies such as dopamine transporter imaging currently offer the highest degree of accuracy for identifying premotor PD. Recent dopamine transporter SPECT and PET studies demonstrated decreased striatal dopaminergic innervations in IRBD patients.

Methods: PET with 6-[(18)F]FMT, which can assess the level of the presynaptic dopaminergic nerve, were performed in 57 patients with IRBD (49 men, mean age 63.5 ± 6.9 years), 15 patients with PD (11 men, mean age 66.5 ± 8.5 years) and 15 control subjects (9 men, mean age 63.5 ± 6.9 years) to assess nigrostriatal function.

Results: There were significant differences in the group 6-[(18)F] FMT uptake levels in bilateral putamen between PD patients and both IRBD patients and control subjects ($p < 0.05$). IRBD patients had neuroimaging evidence of almost intact striatal dopaminergic innervation, similar to controls, and did not exhibit the reduced uptake exhibited in PD.

Conclusion: Dopamine transporter PET seem to be helpful in identifying patients with IRBD potentially at risk to develop PD. However, more longitudinal follow-up studies are necessary to estimate the ratio of patients with dopaminergic cell loss in the basal ganglia who will develop PD in the future.

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0611

A SCREENING STUDY OF REM SLEEP BEHAVIOR DISORDER QUESTIONNAIRE (RBDQ-HK) IN PATIENTS WITH SLEEP-DISORDER

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Introduction: The prevalence of REM sleep behavior disorder (RBD) is approximately 0.5% in the general population. We assessed the prevalence of RBD in a sleep laboratory population and evaluated the sensitivity and the specificity of RBD questionnaire-Hong Kong (RBDQ-HK) in screening RBD patients.

Methods: A 13-item self-rating RBD questionnaire (RBDQ-HK) was applied to 915 consecutive patients [43.2 ± 12.6 years (10-78 years); 640 males] who underwent polysomnography (PSG). The patients included nearly full spectrum of sleep disorders in ICSD-2. An RBDQ-HK total score cutoff of 18 was used to distinguish RBD. Forty-five healthy subjects who excluded RBD were recruited to serve as control group [45.6 ± 13.1 years (12-75) years; 32 males].

Results: In total observer patients, 11 patients (1.2%) were diagnosed as RBD (6 men and 5 women, 48.4 ± 15.0 years) according to the diagnostic criteria in ICSD-2. Seven patients (63.6%) were idiopathic and 4 patients (36.4%) were symptomatic. RBD patients had greater total

score on RBDQ-HK (48.1 ± 8.7) than non-RBD patients had (14.3 ± 11.1) ($p < 0.001$). In 904 non-RBD patients, nearly 30% of them had the total score of RBDQ-HK greater than 18. Based on ICSD-2, considering a total score greater than 18 on RBDQ-HK as a diagnosis of RBD, we found a sensitivity of 1.00 and a specificity of 0.70 in a group of sleep-disorder patients. In control group, the total score on RBDQ-HK (9.6 ± 4.6) was significantly lower than in the RBD group ($p < 0.0001$), and 2 patients (4.4%) had total score of RBDQ-HK greater than 18, revealing a specificity of 0.96.

Conclusion: The prevalence of RBD is 1.2% in sleep-disorder patients. The RBDQ-HK has a high sensitivity and it can be a useful tool for the screening of RBD.

0612

POTENTIAL CAUSES OF NIGHTMARES AMONG VETERANS: GETTING AWAY FROM PTSD

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Introduction: Nightmares are often associated with PTSD among veterans, but little is known about other factors that might be associated with nightmares, especially in the absence of PTSD.

Methods: One-hundred sixty-two available patients with a diagnosis of nightmares and 648 controls matched 4:1 by year of first nightmare diagnosis, were selected from a random sample of 7200 veteran patients who sought primary care at JAHVA medical center between 2000 and 2012. To identify correlates of nightmares, an exploratory analysis examined demographics, BMI, laboratory results and concomitant diagnoses made within two years of the first diagnosis of nightmares (or matching date for controls). Linear and logistic regression, adjusted for age, gender and race were used respectively for continuous and dichotomous variables. The precision index (odds ratio/std-dev) was used to identify the ten ICD-9 diagnostic codes most strongly associated with nightmares.

Results: Only 29.0% of patients with nightmares vs. 10.5% of controls had PTSD (OR = 3.2, $p < 0.001$). Other significant correlates included younger age (59.8 vs. 65.0 years), White race, higher BMI (32.2 vs. 29.7), triglycerides and CO₂. Almost half of patients with nightmares had obstructive sleep apnea (OSA) (46.9% vs. 8.8%, OR = 9.3, $p < 0.001$) and an explicit code for obesity (43.8% vs. 23.1; OR = 2.4, $p < 0.001$). Other diagnoses associated with nightmares included dietary counseling (OR = 2.2, $p < 0.001$), fitting an orthopedic device (OR = 2.7, $p < 0.001$), physical rehabilitation (OR = 3.0, $p < 0.001$), osteoarthritis (OR = 2.8, $p < 0.001$), back ache (OR = 2.1, $p < 0.01$) and major depressive disorder (OR = 4.6, $p < 0.001$).

Conclusion: Among veterans, OSA, rather than PTSD, may be the primary comorbidity associated with nightmares. Further research is needed for causal inference. Investigation is warranted to determine if physical rehabilitation and the fitting of an orthopedic device are secondary to a prior amputation; if so the association between amputation and nightmares should be studied.

0613

NIGHTMARES OF SLEEP: THE EFFECT OF REM-APNEA HYPOPNEA INDEX

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Introduction: Nightmares may continue into adulthood. They can be just one way our brain has of dealing with the stresses and fears of everyday life. The goal of the current study was to estimate the prevalence of sleep nightmares in the general population who underwent polysomnography (PSG) examinations and to evaluate the relation between RME-AHI and reported nightmares during the study night.

Methods: We included 177 individuals who underwent polysomnography (PSG) examinations and filled the night-after questionnaires regarding the presence of nightmares during the study nights and the characteristics of these nightmares.

Results: 177 patients (87 females and 90 males) were included. 40 (24.2%) reported nightmares during the night of PSG. 9.1% reported nightmares associated with acting out those dreams. Only 2 patients had clinical presentations suggestive of “acting out dreams” on the associated video recording. Patients who reported nightmares tend to be younger (44.92/ 13.23 vs 51.92/25.57, $P = 0.03$), had with higher AHI (but non-significant) (30.75 vs 23.85, $P = 0.2$). REM-AHI did not differ significantly between the nightmares vs the non-nightmares groups: (33.73 vs 31.81 $p = 0.73$). Arousal indices were not significant also (30.94 vs 32.35 $p = 0.763$).

Conclusion: We found no significant correlation between REM-AHI and reported nightmares during polysomnogram. Patients with nightmares tend to be younger and with higher but non significant AHI. This is in contrast to previous study showing reduction of nightmares frequencies with increased AHI. Further studies are needed.

0614

EEG FUNCTIONAL CONNECTIVITY AS AN INVESTIGATIVE TOOL IN ADULT SOMNAMBULISM

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Introduction: There has been increased interest in examining sleep EEG data in terms of functional brain connectivity. Sleep is ideally suited for these kinds of analyses because it minimizes between-subject variability that can confound analyses of waking state events. These new investigative tools, however, remain practically unexplored in relation to sleep disorders. We studied the EEG coherence and interdependencies between brain areas before the onset of somnambulistic episodes recorded in the sleep laboratory.

Methods: Thirteen adult sleepwalkers were investigated with polysomnography. Patients were selected on the basis of having experienced a somnambulistic episode in the sleep laboratory during their first period slow-wave sleep (SWS). The 20 seconds immediately preceding the onset of each of the 13 episodes were compared to the 20 seconds occurring two minutes prior to these episodes' onset. Data from the Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2 leads were investigated using two complimentary measures of brain connectivity: standard coherence and imaginary coherence (the latter addressing the problem of spurious correlations due to common sources).

Results: The largest observed difference between the 20 second periods occurring immediately prior to episode onset versus the 20 second segments occurring 2 min before episode onset was in imaginary coherence with greater connectivity taking place immediately preceding sleepwalking episodes. Furthermore, increased connectivity was strongest between frontal and occipital brain areas.

Conclusion: These pilot findings suggest that episodes of somnambulism are preceded by temporal changes in brain connectivity and that a direct interdependence between frontal and occipital brain regions may be implicated. The study of EEG connectivity in relation to NREM parasomnias may help elucidate brain processes underlying episode occurrence. As a follow-up to these pilot results, we are currently examining patterns of brain connectivity as a function of episode complexity, select frequency bands, and subsequent to sleep deprivation.

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0615

EATING HABITS, PERSONALITY TRAITS AND POLYSOMNOGRAPHIC FEATURES OF NON-OBESE PATIENTS AFFECTED BY NOCTURNAL EATING

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Introduction: Nocturnal eating is a behaviour shared by patients affected by an eating disorder, Night Eating Syndrome (NES) and a parasomnia, Sleep Related Eating Disorder (SRED), but the borders between the two syndromes are not completely defined, moreover personality traits and polysomnographic features of these patients have been poorly studied. Aim of this study is to evaluate the polysomnographic characteristics and personality traits of a sample of patients affected by NES.

Methods: 30 patients affected by NES underwent a full night video-PSG study and a psychometric assessment including the Eating Disorder Inventory (EDI-2), the self-rating Bulimic Investigatory Test, Edinburgh, the Temperament and Character Inventory and the Barratt Impulsivity Scale.

Results: We found a mild reduction in sleep efficiency and sleep duration due to a moderate sleep fragmentation, while the percentages of the single sleep stages were not significantly affected. NES scored significantly higher on many subscales of the Eating Disorders Inventory-2: drive for thinness, body dissatisfaction, bulimia, interoceptive awareness, asceticism and impulse regulation, such as on the Bulimic Investigatory Test Edinburgh, symptoms subscale. We also found in these patients higher levels of impulsivity and sensitivity to reward.

Conclusion: All these characteristics are typical of patients affected by eating disorders, further sustaining the hypothesis that their nocturnal behavior is due to an eating disorder more than a parasomnia.

0616

ONABOTULINUM TOXIN-A INJECTIONS FOR NOCTURNAL BRUXISM: A PARALLEL, DOUBLE BLIND, PLACEBO CONTROLLED POLYSOMNOGRAPHIC STUDY

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Introduction: Bruxism is probably the most common parasomnia, occurring in up to 15% of the population. There is no widely accepted treatment other than bite guards to limit dental damage.

Methods: We performed a double blind, placebo injection controlled (1:1) trial of onabotulinum-A (BoNT) for nocturnal bruxism. Patients

underwent a baseline/screening overnight polysomnogram (PSG). They were then randomized to receive BoNT or placebo into the bilateral masseter (60 u/side) and temporalis muscles (40 u/side) using visual landmarks. Primary efficacy points were CGI and VAS of change at 4 weeks post injection. Secondary points including change in PSG data, including masseter placed electrodes, pain scales, sleep scales, and adverse events.

Results: Eight subjects were excluded after the initial PSG prior to randomization (six for lack of bruxism on PSG and two declined to continue). Twenty-three (19 female, age 47.4 (16.9) were randomized. Almost all reported temporal-mandibular pain. All 13 randomized to drug and 9/10 randomized to placebo completed the study. CGI ($p < 0.05$) and VAS of change ($p < 0.05$) favored the BoNT group. Secondary scales including the Headache Impact Test-6, total Pittsburgh Sleep Quality Index, Epworth Sleepiness Scale, and Self-Rated Anxiety Scale were not significantly changed. A large percentage of subjects had moderate obstructive sleep apnea on PSG despite lack of typical risk factors. The mean duration to open label f/u injection was 107 days in those randomized drug vs. 40 days in those randomized to placebo. Adverse events were limited to 2 subjects with a cosmetic change in their smile. No dysphagia was reported and apnea did not worsen.

Conclusion: BoNT effectively and safely improved nocturnal bruxism in this small pilot trial. Multi-center confirmatory trials are justified.

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0617

PRELIMINARY STUDY: BRAIN IRON DEFICIENCY IN RESTLESS LEGS SYNDROME/WILLIS EKBOM DISEASE (RLS/WED) ASSESSED WITH QUANTITATIVE SUSCEPTIBILITY MAPPING (QSM) AT 7T IN RELATION TO SLEEP AND CORTICAL EXCITABILITY

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Introduction: Brain iron deficiency particularly for the substantia nigra (SN) has been found in several RLS/WED studies. Mapping the areas of brain iron deficiency in RLS/WED and relating these to biological measures or symptoms could indicate brain areas of significance for RLS/WED. Prior MRI iron studies using R2* and R2 have limited sensitivity for detecting iron deficiency in regions of the brain which already have low brain iron in normal subjects, e.g. the thalamus. Quantitative magnetic susceptibility mapping (QSM) provides high resolution maps of magnetic susceptibility that have been shown to correlate well with more direct measures of tissue iron concentrations. Prior RLS/WED studies documented increased corticomotor excitability measured by paired pulse transcranial magnetic stimulation (TMS). This study investigates the use of 7T QSM for measuring brain iron in RLS/WED subjects and normal controls, and its relationship to TMS and sleep measures.

Methods: Sixteen RLS/WED patients off medications for 10 days and 7 age, sex matched healthy controls had QSM iron assessment with the primary targets of SN and thalamus. TMS was assessed for short interval intracortical inhibition (SICI) of the abductor pollicis brevis. Leg movements were measured from all night studies.

Results: QSM images provided good tissue contrast indicating reduced iron concentration for SN, red nucleus (RN), dentate nucleus and the thalamus but little difference for the striatum. Decreased iron correlated significantly for the SN with increased sleep leg movements ($r = -0.33$, $p < 0.05$) and for the thalamus with decreased SICI ($r = 0.33$, $p < 0.05$).

Conclusion: 7T QSM provides high-resolution maps of brain iron content, including regions with low iron content. Iron content in different regions may indicate brain regions significant for different aspects of RLS/WED, e.g., corticomotor excitability, leg movements.

0618

EFFICACY OF TRANSCRANIAL DIRECT CURRENT STIMULATION IN PATIENTS WITH DRUG-NAÏVE RESTLESS LEGS SYNDROME

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Introduction: Although dopamine agonists are widely used to treat restless legs syndrome (RLS), drug emergent problems like dopamine dysregulation syndrome and augmentation may limit their use for long term therapy. Since various transcranial magnetic stimulation studies and electroencephalography (EEG) studies revealed altered cortical excit-

ability in RLS, transcranial direct current stimulation (tDCS), which can modulate cortical excitability, might offer a therapeutic target in RLS. Therefore, we evaluated the efficacy of tDCS in patients with drug-naïve RLS for the first time.

Methods: In a randomized, double-blind, sham-controlled, and proof-of-concept clinical trial, we applied 20 min of anodal or cathodal tDCS at 2mA over Cz area. After completing baseline assessments (T0), 33 female patients were randomly assigned to receive cathodal, anodal, or sham tDCS treatment in a 1:1:1 ratio. They were subsequently assessed 3 days (T1) and 13 days (T2) after the end of tDCS treatment. Primary outcomes included the International RLS Group Rating Scale (IRLS) and the Clinical Global Impressions-Improvement (CGI-I). Objective neurophysiological evidence of hyperexcitability were assessed using event-related synchronization (ERS) at β -band obtained during finger tapping task in an EEG study. Acute effects were assessed using visual analogue scale (VAS). We used the Statistical Package for the Social Sciences version 17.0 and R (version 3.0.1) for statistical analyses.

Results: IRLSs were significantly lower at T1 and T2 (17.8 ± 5.6 and 17.9 ± 7.8 , respectively), compared to that at T0 (28.7 ± 4.3 ; $p < 0.01$ for both). However, the changes in IRLSs at T1/T2 and the percentages of CGI-I responders at T1/T2 did not differ significantly among three groups ($p = 0.377$, $p = 0.897$, $p = 0.131$, and $p = 0.940$, respectively). Although VAS improved gradually during the tDCS sessions, VAS scores at each day did not differ significantly among three groups. There were no significant effects of tDCS on β -ERS among three groups ($df = 2$, $F = 0.422$, $p = 0.660$), between pretreatment and post-treatment ($df = 1$, $F = 0.179$, $p = 0.676$), and in 'group \times treatment' interaction ($df = 2$, $F = 1.032$, $p = 0.369$). Correlation analysis showed that the changes in β -ERS were negatively correlated with the VAS just after the last tDCS treatment ($p = -0.394$, $p = 0.031$). There were no differences in the number of patients with any kinds of adverse effects among the groups.

Conclusion: Our study suggests that the tDCS treatment in RLS patients is not effective compared to the sham tDCS treatment. β -ERS seems to reflect the severity of RLS symptoms.

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0619

RIGHT TEMPORAL LOBE AND UNCINATE FASCICULUS STRUCTURAL ABNORMALITIES IN RLS

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Introduction: Both morphometric and diffusion tensor imaging (DTI) studies in restless legs syndrome (RLS) have been marked by inconsistency of results, potentially due to differences in methodology. The aim of this study was to investigate brain abnormalities in RLS at the macro- and micro-structural level using improved methods.

Methods: Eighteen subjects with primary moderate-severe RLS, either unmedicated ($n = 8$) or with a 2-day washout ($n = 10$), and 18 age- and gender-matched controls were enrolled and scanned using a 3T MRI scanner (one control had unusable data). Morphometric data processing was performed with the VBM8's DARTEL algorithm. Maps were thresholded at $p < 0.005$ (uncorrected) with an extent threshold empirically determined by SPM8. The DTI data processing and tractography were performed using FSL-FDT and TRACULA by extracting the standard diffusion measures (i.e., fractional anisotropy [FA], axial diffusivity [AD], radial diffusivity [RD], and mean diffusivity [MD]). The estimated pathway of interest (uncinate fasciculus) was determined following the VBM results.

Results: VBM analysis revealed significantly reduced volume in the right temporal lobe of the RLS group ($p < 0.001$, 147 voxels). The multivariate result for the DTI analysis was significant for group (Wilks' Lambda = .675, $p = .05$), with a reduced diffusion in the uncinate fasciculus in the RLS group compared to controls. There was a significant difference between groups for FA (left: $p = .03$; right: $p = .03$), MD (left: $p = .02$; right: $p = .10$), and RD (left: $p = .02$; right: $p = .10$), with reduced FA/RD and increased MD in the patient group. FA values correlated with symptom severity in the RLS group (left: $r = -0.50$, $p = 0.03$; right: $r = -0.57$, $p = 0.01$). AD was no different between groups.

Conclusion: Our data suggests that the right temporal lobe and its connection to the frontal lobes may be involved in the pathophysiology of RLS, though this may also represent the effects of sleep disruption or medications.

0620

PERIODIC LIMB MOVEMENTS DURING SLEEP AND HYPERTENSION IN THE MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS

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Introduction: Periodic limb movements during sleep (PLMS) are associated with immediate increases in blood pressure and both PLMS and hypertension (HTN) have differential expression by race/ethnicity. The purpose of this study is to determine if PLMS associates with daytime hypertension and if this association is modified by race/ethnicity in a multiethnic population.

Methods: 1,740 men and women underwent polysomnography (PSG) with measurement of PLMS then blood pressure in triplicate on a separate visit. HTN was defined as systolic blood pressure (SBP) ≥ 140 , diastolic BP ≥ 90 or taking anti-hypertensive medication. SBP_{imputed} was derived from imputed SBP values based upon anti-hypertensive medication usage, dosage and previously recorded BP values. Measures of PLMS including PLMS index (PLMI) and PLMS arousal index (PLMAI) were the main explanatory variables. HTN and SBP_{imputed} were modeled with logistic and multivariate regression adjusted for age, sex, body mass index, cardiovascular risk factors, lifestyle/habitual factors and apnea-hypopnea index.

Results: In the overall cohort, HTN was modestly associated with PLMI (10-unit) (OR 1.05 [95% CI 0.99, 1.10]; $p = 0.055$) or PLMAI (1-unit) (1.05 [1.01, 1.09]; $p = 0.02$) after adjusting for multiple confounders. Unlike other races in African-Americans, there was a pronounced association between HTN and PLMI (10-unit) (1.21 [1.01, 1.45]; $p = 0.02$) or PLMAI (1-unit) (1.23 [1.04, 1.45]; $p = 0.003$) such that the odds of HTN increased by 21% for 10-unit PLMI increase and 23% for 1-unit PLMAI increase. SBP_{imputed} was not associated with PLMS frequency in the overall cohort. In African-Americans, SBP_{imputed} was associated with PLMAI (1.01 [0.04, 1.98]; $p = 0.04$), such that every 1-unit increase in PLMAI was associated with a SBP increase of 1.01 mmHg.

Conclusion: In a multiethnic cohort of community dwelling men and women, prevalent HTN and SBP is associated with PLMS frequency in African-Americans but not other races/ethnicities.

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0621

RESTLESS LEGS SYNDROME IN NEUROLOGICAL WILSON'S DISEASE

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Introduction: To determine prevalence and characteristics of restless legs syndrome (RLS) in Wilson's disease (WD), excluding RLS mimics.

Methods: Extended structured clinical interviews (patients and caregiving family members), neurological and clinical examinations, comprehensive laboratory tests, and rating scales (Unified WD Rating Scale [UWDRS], Global Assessment Scale for WD, IRLS severity scale).

Results: WD patients ($n = 41/f = 17$) had first symptoms of WD at age 18.0 ± 6.1 yrs (mean \pm SD) and were examined at age 34.2 ± 9.4 yrs. All had a neurological WD, with almost no hepatic manifestation (Child-Pugh A $n = 38$, B $n = 3$). WD was slightly disabling in nine, moderately disabling in 16, and severely disabling in further 16 patients. 15 WD patients, eight males and seven females, had RLS (two of them highly probable RLS; prevalence 36.6%). Age at RLS begin was 26.7 ± 10.8 yrs. All but two developed RLS after having developed symptoms of WD (elapsed time 8.5 ± 13.6 yrs, range -13 to 38 yrs). Mean IRLS score was 15.9 ± 8.7 , corresponding to a moderate RLS. In 11 RLS patients, symptoms occurred on average at least twice weekly for the past year and caused clinically significant distress. Family history of RLS was positive in two RLS patients, clinical signs of polyneuropathy in three (confirmed by nerve conduction velocity studies in two), none had serum ferritin lower than $50 \mu\text{g/l}$. WD+RLS patients were older (37.1 ± 10.3 yrs) than WD/no-RLS patients (32.5 ± 8.6 yrs; $p < 0.1$). None of the RLS patients had been diagnosed nor had been treated specifically.

Conclusion: These are the first quantitative data on RLS in WD. Our group of 41 neurological WD patients shows a high RLS prevalence of 36.6%. The RLS characteristics found are suggestive of a secondary form of the syndrome. WD's specific RLS mimics are frequent and complex (motor restlessness due to dystonia, resting and postural tremor, chorea); they demand an extra diagnostic effort to be distinguished from RLS.

Support (If Any): São Paulo Research Foundation 2012/05403-3.

0622

RESTLESS LEGS SYNDROME AND HIV: IMPLICATIONS FOR THE MANAGEMENT OF INSOMNIA

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Introduction: The higher prevalence of restless legs syndrome (RLS) amongst people living with HIV-AIDS (PLWHA) has been the object of a single publication showing a prevalence of 33% exclusively within 129 Caucasians (including only 15% females) contrasting with a lifetime prevalence around 15% in the general population. Another limitation was the low response rate (52%) to their questionnaire diagnosing RLS. We propose to estimate the prevalence of RLS in PLWHA seeking help for chronic insomnia.

Methods: Twenty-seven ambulatory HIV-seropositive patients, 14.8% Caucasians and 85.2% African-Americans, including a total of 8 females (29.6%), aged 43-59 years (mean \pm SD: 52.4 ± 4.5 years), with a complaint of DSM-IV insomnia for at least 3 months and all currently taking highly active antiretroviral treatment (HAART) were enrolled in a study on the feasibility of non-pharmacological treatment of insomnia

in PLWHA. Screening process included the Duke Structured Interview for Sleep Disorders (DSISD), which identifies RLS.

Results: Based on the DSISD, 17 out of 27 (65.4%) met criteria for ongoing RLS. The χ^2 for the difference between the prevalence of RLS within our PLWHA sample and within the general population was highly significant (51.8 with 1 degree of freedom (df) and a two-tailed $p < 0.0001$). The χ^2 for the difference between the prevalence of RLS within the only published study and ours was also highly significant (12.3 with 1 df, two-tailed $P = 0.0004$).

Conclusion: We confirm the much higher prevalence of RLS within PLWHA seeking treatment for chronic insomnia (65.4%) compared to PLWHA in general (33%) and the general population (15%). This further supports that RLS might be an important reason for non-restorative sleep in HIV while likely caused by a hypodopaminergic state, and offers another target for therapy to decrease daytime fatigue, and improve HAART adherence.

Support (If Any): Small Innovative Grant Program supported by the Center for AIDS Research (CFAR), Duke University.

0623

A NEUROPHYSIOLOGICAL STUDY OF SLEEP LEG MOVEMENTS IN ACUTE SPINAL CORD INJURY

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Introduction: Periodic leg movements during sleep have been reported to occur in myelopathy; however, the pathophysiological basis of leg movements occurring in spinal cord injury is incompletely known. The objective of this study was to analyze the periodicity of leg movement activity emerging during sleep in a group of patients with spinal cord injury and to evaluate their pathophysiological features.

Methods: Twenty patients (16 males, mean age 34.0 years) with traumatic spinal cord lesions were recruited (five cervical, 15 thoracic; 16 level A and 4 level B at the American Spinal Injury Association impairment scale). Periodicity of sleep leg movements was analyzed; electroencephalographic spectral analysis and heart rate were evaluated for 20 s preceding and 30 s following the onset of leg movements.

Results: Eleven patients (group I) did not show any increase in heart rate related to the occurrence of leg movements while the remaining nine did (group II). Two patients in each group had American Spinal Injury Association impairment level B; five patients of group I and none of group II had cervical lesions while 6 patients of group I and all nine of group II had thoracic lesions. Only two patients in group I presented clearly periodic leg movements during sleep. Electroencephalographic delta, alpha and beta bands around leg movements increased clearly in group II while the changes in group I were very limited or absent.

Conclusion: The disconnection from higher nervous structures, in patients with spinal cord injury might favor the appearance of leg movements due to the activity of spinal generators not inhibited by higher influences; correlated autonomic and electroencephalographic changes can be absent. This motor activity might assume the periodic character in a subset of patients with a genetic predisposition for periodic leg movements during sleep.

0624

OBSTRUCTIVE SLEEP APNEA (OSA) IS AFFECTED BY LEVODOPA EVENING DOSE IN PARKINSON'S DISEASE (PD)

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Introduction: Obstructive sleep apnea (OSA) occurs frequently in PD patients, but the effect of levodopa, the main PD treatment, on OSA is unknown. Our objective was to evaluate the association between levodopa and OSA in PD.

Methods: Thirty-eight PD patients underwent overnight diagnostic polysomnography (PSG). They were grouped as follows: late dose long acting levodopa (LALD, $n = 8$); late dose short acting levodopa (SALD, $n = 15$); and no late dose levodopa (NLD, $n = 17$). A dose was considered late if taken ≥ 8 pm. Outcomes of interest were apnea-hypopnea index (AHI), spontaneous arousal index (SAI), respiratory arousal index (RAI), periodic limb movement arousal index (PLMAI), total arousal index (TAI) and oxygen desaturation index ($\geq 4\%$, ODI). PSG records were also split at the mid-point of the sleep period and each half analyzed separately. Analyses were done by ANOVA, adjusting for percent time in REM sleep, percent time in supine position, PD motor severity, body mass index (BMI) and age, followed by appropriate post-ANOVA comparisons.

Results: Subjects were 53% male, aged 63.5 ± 10.8 y (mean \pm SD), with BMI 25.9 ± 3.2 kg/m², Hoehn and Yahr stage 2.0 ± 0.82 , AHI 24.6 ± 18.3 /h. LALD and SALD, compared with NLD, had lower AHI (10.7 ± 9.9 /h, 22.2 ± 13.8 /h and 31.5 ± 21.0 /h respectively, adjusted $p = 0.001$), RAI (9.4 ± 8.7 /h, 20.7 ± 13.4 /h and 27.6 ± 17.0 /h, $p = 0.004$), TAI (26.5 ± 10.7 /h, 39.8 ± 16.9 /h and 45.5 ± 19.0 /h, $p = 0.01$) and ODI (1.3 ± 1.8 /h, 1.4 ± 1.5 /h and 5.1 ± 7.7 /h, $p = 0.02$). In the first half of the PSG, LALD and SALD had lower AHI, RAI, TAI (trend for SALD) and ODI (trend for LALD) than NLD. In the second half, only LALD had lower AHI and RAI compared with NLD. There were no differences in PLMAI or SAI.

Conclusion: In PD, long acting levodopa taken before bedtime may be associated with reduced OSA severity and related sleep fragmentation throughout the night, while short acting levodopa appears to have this association only in the first half of the night.

Support (If Any): Research Institute of the McGill University Health Centre, VitalAire Inc, Philips Respironics.

0625

CLINICAL COURSES OF RESTLESS LEGS SYNDROME IN A SLEEP CLINIC

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Introduction: The aim of this study is to examine clinical courses of restless legs syndrome (RLS) according to RLS severity, and associated factors for remission of RLS symptoms.

Methods: Among RLS patients diagnosed from November 2004 to November 2011 in the sleep clinic of Seoul National University Bundang Hospital, we investigated the remission or persistence of RLS symptoms by face-to-face or telephone interview. All subjects were observed for at least 18 months and the remission was defined as having no RLS symptoms for 1 year or longer. The RLS severity was evaluated by international RLS study group scale (IRLS). Survival analysis was used to

calculate cumulative incidence of remission by RLS severity, and hazard ratios (HR) for associated factors of RLS remission were obtained.

Results: Of a total of 398 eligible patients, 306 were finally included in this study. The observation period was 4.1 ± 1.6 (range, 1.5-8.5) years and IRLS score was 20.3 ± 8.5 at baseline. Over observation periods, 96 (31.4%) RLS patients showed remission. The cumulative incidence of remission decreased with RLS severity ($p < 0.001$); 60% (95% CI, 44.9-75.1), 44% (95% CI, 34.4-53.6) and 16.7% (95% CI, 10.6-22.8) in mild, moderate and severe to very severe RLS patients. Most of remission (82 of 96, 85%) was observed within 1 year, and mild RLS showed remission in much shorter period. Comparing with mild RLS, HR of remission was lower in moderate (0.532; 95% CI, 0.321-0.883) and severe to very severe (0.186; 95% CI, 0.104-0.335) RLS. The presence of family history and older age at RLS diagnosis decreased remission incidence.

Conclusion: Mild severity, no family history and younger age at RLS diagnosis were associated with prediction of remission. More than 80% of severe RLS patients have chronic clinical courses.

0626

RESTLESS LEGS SYNDROME IN EVENING UNDERGRADUATE STUDENTS

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Introduction: Restless legs syndrome (RLS) is characterized by an urgent need to move the legs that is temporarily relieved by movement and occurs at rest and at night. Currently, its prevalence in Brazil is estimated at 6.4%. Evening undergraduate students are prone to poor sleep quality and may constitute a risk group for RLS as, during the classes, they are subjected to extended periods of relative physical inactivity and variable mental activity according to fluctuations in the level of attention.

Methods: This is a cross-sectional self-administered questionnaire-based survey. Students from first to fourth year of five evening undergraduate courses of a public federal university in Brazil were asked to answer a questionnaire to ascertain presence of RLS diagnostic criteria, demographic and clinical characteristics, Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS). Statistical analysis included multivariate logistic regression to identify significant associations.

Results: Among the 630 students who correctly completed all questions, mean age was 23.8 ± 5.8 years and 360 (57.1%) were female. Sixty-seven (10.6%) students presented RLS diagnostic criteria, 333 (52.9%) presented excessive daytime sleepiness (EDS) and 262 (41.6%) were categorized as poor-quality sleepers by the PSQI. RLS was associated to female gender (13.3% vs 7%, $p = 0.01$) and poor sleep quality (19.1% vs 4.6%, $p < 0.001$). On female gender students, RLS was related to abnormal uterine bleeding (23.4% vs 12%, $p = 0.04$). Poor sleep quality was also associated to higher mean age (23.3 ± 5.9 vs 24.4 ± 6.3 years, $p < 0.001$), daytime work (45.4% vs 30.9%, $p = 0.007$) and EDS (50.8% vs 31.3%, $p < 0.001$).

Conclusion: RLS, poor sleep quality and EDS are common in evening undergraduate students. Poor sleep quality is related to higher mean age, daytime work, EDS and RLS. RLS is related to female gender. In women, RLS is related to the complaint of abnormal uterine bleeding.

Support (If Any): Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

0627

PROBLEMS ABOUT DIAGNOSIS AND REFERRAL PROCESS OF RESTLESS LEGS SYNDROME IN JAPAN

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Introduction: There is no objective gold standard for making a diagnosis of restless legs syndrome (RLS), which makes it difficult for non-sleep specialists to approach this disease. In addition, no consensus has been made about which specialist (i.e., neurologists or sleep specialists) should play a main role in the management of RLS patients in Japan. We aimed at extracting problems in the referral process of patients with genuine RLS and RLS-mimic disorders to our sleep clinic.

Methods: Consecutive 63 patients (man 26/ woman 37, age: 55.5 ± 18.2 years) who came to our clinic suspected of RLS from May 2005 to November 2013 were retrospectively studied. Their referring process, primary complaints, previous medication, final diagnosis, and management problems due to their referral were collected from the progress notes.

Results: Fourteen patients out of 55 who were confirmed to have RLS presented themselves by their own after getting information about RLS through newspaper articles or the internet. Nine patients with RLS had consulted more than one physician or orthopedic surgeon without proper diagnosis before self-referring to our clinic. 21 patients were referred by non-sleep specialists, because RLS (14 patients), or other neurological/sleep disorders (3 patients) were suspected, and they were informed of the knowledge of RLS by the patients (4 patients). The remaining 11 RLS patients were: coming to our clinic due to complaint of poor control of RLS symptoms at the previous physician (7 patients), no guidance after drug trials completed elsewhere (2 patients), and the new onset of RLS in patients who had been treated for other sleep disorders in our sleep clinic (2 patients). In 4 patients out of 8 with RLS-mimic disorders, treatment for RLS had been already started elsewhere.

Conclusion: RLS is still not well recognized among non-sleep specialists and the information about RLS seems to disseminate more among the public rather than medical providers in Japan. There is an urgent need for the medical community to establish proper referral hierarchy in the management of RLS.

0628

CHILDHOOD RESTLESS LEGS SYNDROME: CLINICAL CHARACTERISTICS AND EFFECTIVENESS OF TREATMENT

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Introduction: Restless legs syndrome (RLS) is a sensory-motor disorder affecting 1-2% of children. Children with RLS may present with daytime symptom which mimic attention deficit hyperactivity disorders. The aim of the study was to identify the clinical characteristics of childhood RLS and to evaluate the effectiveness and tolerability of medication in patients with moderate to severe childhood RLS.

Methods: Eight children with RLS (3 boys, 5 girls, age: 4-14 years old) were evaluated for the clinical characteristics including the severity, serum ferritin levels and the daytime symptoms. All children were treated and the effectiveness was assessed for both nocturnal and daytime symptoms. Safety assessments included adverse events were also conducted.

Results: All children were moderate to severe RLS and half of them suffered from daytime symptom especially the urge to move of the legs

during classes. All patients were treated with iron, and four of them were also treated initially with pramipexole. Three de novo patients and three pre-treated patients were treated with rotigotine transdermal patch with the maintenance dose of 0.56-4.50 mg. Rotigotine improved the RLS symptom in all patients especially the daytime symptom. Itchiness or a skin rash was observed in three patients.

Conclusion: Daytime symptom of childhood RLS occurred mostly while sitting during classes. Rotigotine transdermal patch was effective for daytime symptom and well-tolerated when used for children with moderate to severe RLS. Skin reaction need be carefully monitored.

0629

DO PERIODIC ARM MOVEMENTS DURING SLEEP EXIST IN HEALTHY SUBJECTS? A PROSPECTIVE POLYSOMNOGRAPHIC STUDY

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Introduction: Despite multiple studies on periodic leg movements in wakefulness (PLMW) and sleep (PLMS), data on periodic arm movements during wakefulness (PAMW) and sleep (PAMS) are scarce and have been reported only in the context of restless legs syndrome or other neurological disease. Data on the prevalence and characteristics of PAM in healthy sleepers are missing. In this study we aimed to investigate PAM during wakefulness and sleep in healthy subjects.

Methods: All participants were healthy sleepers selected from a representative population sample in a two-step screening procedure (telephone interview and personal assessment by a physician trained in sleep medicine). One night of video-polysomnography was performed according to American Academy of Sleep Medicine 2007 guidelines. In addition to standard electromyographic recording (mentalis, bilateral anterior tibialis muscles) bilateral flexor digitorum superficialis muscles were recorded. PAM and PLM were scored according to the criteria of the World Association of Sleep Medicine.

Results: Sixty-two participants (68.1%) had a PAM index during wakefulness (PAMW) > 5/h and only seven (7.7%) showed a PAM index > 5/h during sleep (PAMS). The median PAM index was 8.8/h (range 0-77) in wakefulness and 0.7/h (range 0-47.4) in sleep. Only 14% of PAMW occurred simultaneously with PLMW, and correlation between PAM and PLM was only weak to moderate (during wakefulness: Spearman Rho = 0.576, $p < 0.001$; during sleep: Spearman Rho = 0.222, $p = 0.036$). The periodicity index of PAM was markedly lower than the periodicity index of PLM ($p < 0.05$).

Conclusion: PAM are frequent in healthy subjects, and occur predominantly during wakefulness with a very low periodicity. It might be suggested that in contrast to classical PLM at least part of PAM do not present a true periodic phenomenon but are just random voluntary movements meeting the wide range of periodicity criteria for PLM.

Support (If Any): The study was supported by FWF Austrian Science Fund KLIF Grant KLI 236 to Birgit Frauscher.

0630

PREVALENCE OF PERIODIC LIMB MOVEMENTS DURING SLEEP IN MALE AND FEMALE PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: There are remarkable differences for the onset of obstructive sleep apnea (OSA) across ages between men and women based on

the epidemiological evidence. These may lead to the variation in comorbid of OSA between male and female. Approximately 25-50% of OSA patients may have periodic limb movements during sleep (PLMS). Via age and severity matched manner, we investigated the prevalence of PLMS in separate male and female patients with OSA.

Methods: Among the patients presented at our sleep medicine center due to the suspicion of OSA, we initially selected 129 consecutive female patients who met the diagnostic criteria of OSA (apnea-hypopnea index, AHI ≥ 5 /h), then selected 129 male patients with OSA, via age and AHI matched manner.

Results: The mean age and AHI were 49.38 ± 11.34 years old and 35.29 ± 26.67 /h in male patients, and 49.74 ± 11.82 years old and 34.17 ± 26.72 /h in female patients, respectively. Among total observed patients with OSA, the prevalence of PLMS was 22.1% and mean of PLMI was 27.26 ± 11.94 /h. The prevalence of PLMS was significantly greater in female than in male patients (27.9% vs. 16.3%; $p < 0.05$), but no difference in PLMI (26.34 ± 11.18 vs. 28.83 ± 13.27 /h; $p > 0.05$). The differences in the prevalence across gender were significant in patients of age ≤ 50 years old (27.9% (17/61) vs. 11.5% (7/61)), not in patients of age > 50 years old (27.9% (19/68) vs. 20.6% (14/68)). Binary linear regression analysis confirmed that females were more likely to have PLMS than males (OR 1.99, 95%CI: 1.09-3.65), particularly in patients of age ≤ 50 years old (OR 2.98, 95%CI: 1.13-7.83).

Conclusion: The results suggest that females may greater prevalence of PLMS in the patients with OSA than males.

Support (If Any): This work was supported by the National Natural Science Foundation of China 81170072 and 81328010.

0631

EFFECT OF SEROTONIN ON PERIODIC LIMB MOVEMENTS IN SLEEP: A CROSS-SECTIONAL STUDY

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Introduction: Several studies have documented elevated periodic limb movements in sleep (PLMS), as defined by the periodic limb movement index (PLMI; the average number of periodic limb movements, as defined by standards set by the American Academy of Sleep Medicine [AASM], per hour of sleep) in subjects receiving serotonin agonists. Nevertheless, no investigations to date have addressed the effects that obstructive sleep apnea (OSA) might contribute to the PLMS noted in this patient population (in one of the largest studies the patients also had OSA).

Methods: Our subjects (patients referred to a sleep laboratory in an academically based hospital to address possible OSA (as defined by an apnea/hypopnea index [AHI; the average number of obstructive respiratory events per hour of sleep] ≥ 5) were studied in retrospective cross-sectional fashion. Information on the use of selective serotonin reuptake inhibitors (SSRI) or serotonin-norepinephrine reuptake inhibitors (SNRI), and the presence or absence of an OSA diagnosis were the main independent variables, and the PLMI and the presence of significant PLMS (as defined by a PLMI > 15) were the primary outcome variables.

Results: Four hundred forty seven subjects with OSA and 401 subjects without OSA were evaluated. Subjects with OSA had a significantly higher mean PLMI (15.7 versus 10.5; Wilcoxon Rank Sum; $P < 0.005$) and a higher prevalence of PLMS (31.3 % versus 19.2 %; t-test; $P < 0.0001$). Among subjects with OSA, there was no significant difference in those receiving or not receiving SSRI/SNRI therapy in regard to the diagnosis of PLMS (respectively 27.6% versus 32.6%), or the mean PLMI (respectively 15.6 and 15.8). However, in the non-OSA group, subjects on SSRI/SNRI therapy had a significantly higher mean PLMI

(13.8 vs. 9.2; $P < 0.05$), and although the prevalence of PLMS was higher (23.7% vs. 17.4%), it was not statistically significant.

Conclusion: This study shows an association between serotonergic drug use and elevated mean PLMI independent of OSA. In addition, although this study also shows OSA is also highly associated with PLMS, no significant difference in the diagnosis of PLMS or the mean PLMI in the OSA groups receiving or not receiving SSRI/SNRI therapies.

0632

WITHDRAWN

0633

THE EFFECT OF GABAPENTIN ENACARBIL ON INDIVIDUAL ITEMS OF THE INTERNATIONAL RESTLESS LEGS SCALE AND POST-SLEEP QUESTIONNAIRE IN PATIENTS WITH SEVERE PRIMARY RESTLESS LEGS SYNDROME: POOLED ANALYSES FROM 3 RANDOMIZED TRIALS

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Introduction: Gabapentin enacarbil (GEN), an actively transported prodrug of gabapentin, has demonstrated significant improvements in restless legs syndrome (RLS) symptoms in adult patients with moderate-to-severe primary RLS compared with placebo (including International Restless Legs Scale [IRLS] total score and post-sleep questionnaire [PSQ] outcomes). In this analysis, we examined GEN's effect on individual IRLS and PSQ items in patients with severe RLS.

Methods: Data were pooled for patients with severe RLS (baseline IRLS total score ≥ 24) receiving GEN (600 mg or 1200 mg) or placebo once daily from the XP052, XP053, and XP081 trials. Analyses were based on the modified intent-to-treat population. Treatment effects were analyzed using a mixed model for repeated measures for the 10 IRLS items and Cochran-Mantel-Haenszel testing for the 5 PSQ items at all time points.

Results: GEN 600 mg and 1200 mg significantly improved least squares mean treatment differences (standard error) for the majority of IRLS items compared with placebo at week 12, including: severity of sleep disturbance (600 mg: 0.43 [0.17], $P = .010$; 1200 mg: 0.60 [0.15], $P < .001$), daytime tiredness (600 mg: 0.47 [0.15], $P = .002$; 1200 mg: 0.57 [0.14], $P < .001$), and severity of mood disturbance (600 mg: 0.34 [0.12], $P = .006$; 1200 mg: 0.38 [0.11], $P < .001$). Per the PSQ, overall sleep quality was significantly improved with GEN 1200 mg vs placebo ($P < .001$); number of hours awake/night due to RLS symptoms was significantly improved with both GEN doses (1200 mg, $P < .001$; 600 mg, $P = .005$). All remaining IRLS and PSQ items were significantly improved with GEN 1200 mg and most (except RLS severity as a whole [$P = .197$]) were significantly improved with GEN 600 mg.

Conclusion: In this pooled analysis, GEN significantly improved the majority of individual IRLS and PSQ items, including clinically relevant sleep-related scores, for patients with severe RLS.

Support (If Any): XenoPort, Inc.

0634

THE EFFECT OF GABAPENTIN ENACARBIL ON INDIVIDUAL ITEMS OF THE INTERNATIONAL RESTLESS LEGS SCALE AND POST-SLEEP QUESTIONNAIRE IN PATIENTS WITH MODERATE-TO-SEVERE PRIMARY RESTLESS LEGS SYNDROME: POOLED ANALYSES FROM 3 RANDOMIZED TRIALS

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Introduction: Gabapentin enacarbil (GEN), an actively transported prodrug of gabapentin, has demonstrated significant improvements in restless legs syndrome (RLS) symptoms in adult patients with moderate-to-severe primary RLS vs placebo (including International Restless Legs Scale [IRLS] total score and post-sleep questionnaire [PSQ] outcomes). In this analysis, we examined GEN's effect on individual IRLS and PSQ items.

Methods: Data were pooled for patients with moderate-to-severe RLS receiving GEN (600 mg or 1200 mg) or placebo once daily from the XP052, XP053, and XP081 randomized trials. Analyses were based on the modified intent-to-treat population. Treatment effects were analyzed using a mixed model for repeated measures for the 10 IRLS items and Cochran-Mantel-Haenszel testing for the 5 PSQ items at all time points. Correlations between each IRLS item and 2 relevant PSQ items (sleep quality and ability to function) were assessed by Spearman's rank-order correlation.

Results: GEN 600 mg and 1200 mg significantly improved all IRLS and PSQ scores compared with placebo. Specifically, GEN improved mean treatment differences (standard error) for the following sleep-related IRLS items vs placebo (week 12): severity of sleep disturbance (600 mg: 0.43 [0.10], $P < .001$; 1200 mg: 0.39 [0.09], $P < .001$), daytime tiredness (600 mg: 0.39 [0.09], $P < .001$; 1200 mg: 0.36 [0.08], $P < .001$), and severity of mood disturbance (600 mg: 0.25 [0.07], $P < .001$; 1200 mg: 0.27 [0.06], $P < .001$). Per the PSQ, GEN significantly improved overall sleep quality ($P < .001$, both doses) and number of hours awake/night due to RLS symptoms ($P = .001$, both doses) vs placebo. Each IRLS item correlated with PSQ-assessed overall sleep quality ($R = 0.21$ to 0.49) and ability to function ($R = 0.21$ to 0.37).

Conclusion: In this pooled analysis, both GEN doses significantly improved all individual IRLS and PSQ item scores, including clinically relevant sleep-related scores. Correlative findings confirmed significant relationships between RLS symptom severity and sleep quality.

Support (If Any): XenoPort, Inc.

0635

EVALUATION OF INTERNATIONAL RESTLESS LEGS SCALE, SLEEP, AND PAIN OUTCOMES AS PREDICTORS OF RESPONSE ON THE PATIENT-RATED CLINICAL GLOBAL IMPRESSION-IMPROVEMENT SCALE IN PATIENTS WITH MODERATE-TO-SEVERE PRIMARY RESTLESS LEGS SYNDROME TREATED WITH GABAPENTIN ENACARBIL: POOLED ANALYSES FROM 2 RANDOMIZED TRIALS

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Introduction: Gabapentin enacarbil (GEN) is an actively transported prodrug of gabapentin. GEN has demonstrated significant improve-

ments in restless legs syndrome (RLS) symptoms, including a significantly greater proportion of responders (“improved” or “very much improved”) on the patient-rated Clinical Global Impression-Improvement scale (PCGI-I) compared with placebo in adults with moderate-to-severe primary RLS. In this analysis, we examined potential predictors of PCGI-I response.

Methods: Data were pooled for patients receiving GEn (600 mg or 1200 mg) or placebo once daily from the XP052 and XP053 randomized trials. Analyses were based on change from baseline to week 12 for 19 items from the International Restless Legs Scale (IRLS), sleep, and pain scales as listed below. Single predictor logistic regression was used to determine the odds of each item to predict PCGI-I response. Stepwise logistic regression and discriminant analysis were used to allow multiple predictors in one model.

Results: Odds ratios (OR, 95% confidence interval) ≥ 4 for the candidate predictors of response, in descending order, were: International Restless Legs Scale (IRLS) total score: 8.70 (5.96, 12.71); RLS symptom frequency: 5.69 (4.21, 7.69); RLS severity as a whole: 5.25 (3.87, 7.11); overall RLS discomfort: 4.94 (3.68, 6.63); sleep disturbance score: 4.78 (3.53, 6.46); RLS quality of life summary score: 4.77 (3.47, 6.57); sleep adequacy score: 4.43 (3.31, 5.92); average RLS severity: 4.28 (3.24, 5.65); overall need to move: 4.25 (3.24, 5.58); average daily RLS pain score: 4.03 (3.03, 5.36). The OR for the remaining RLS- and sleep-related items ranged from 1.36-3.38. When multiple predictors were allowed in the model, no individual variable predicted response better than others.

Conclusion: In this pooled analysis, the most robust predictor of PCGI-I response was IRLS total score. Measures of RLS frequency and severity, and assessments of sleep disturbances, were also good predictors of response.

Support (If Any): XenoPort, Inc.

0636

CHANGE OF FUNCTIONAL CONNECTIVITY OF THE THALAMUS IN RESTLESS LEGS SYNDROME PATIENTS INDUCED BY DRUG TREATMENT: A RESTING-STATE CONNECTIVITY STUDY USING FMRI

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Introduction: This study evaluates changes of resting functional connectivity in RLS patients after drug treatment.

Methods: Resting state fMRIs were obtained in the morning from 32 idiopathic, age and sex matched RLS patients (16 drug naïve, 16 drug treatments) and 16 healthy controls (57.9 \pm 10.5). The treatment group consisted of 8 on dopamine agonists and 8 on dopamine agonists with alpha-2-delta drug for average \pm sd 12.28 \pm 7.76 months. Resting state fMRIs were analyzed using AFNI software based on a seed-based method using the bilateral ventral posterolateral thalamic nucleus. The one-way ANOVA was used for comparing the connectivity strength between the thalamus and other brain regions, among three groups: drug naïve, drug treatment, healthy controls (FWE corrected p-value = 0.05).

Results: We found significant differences of connectivity between the thalamus and the left middle cingulate cortex (Lt. MCC), the right middle temporal gyrus (Rt. MTG), the right postcentral gyrus (Rt. PCG), the right middle frontal gyrus (Rt. MFG), the left anterior cingulate cortex (Lt. ACC), and the left superior temporal gyrus (Lt. STG). In the treat-

ment group, the basal connectivity strength of the Lt. MCC and Rt. PCG with the thalamus changed to be more like those of the healthy controls while those of the drug naïve group remained aberrant. There were also augmented connections between the thalamus and the Rt. MTG, Lt. ACC and Lt. STG in the treatment group, while the drug naïve group showed similar strength of connectivity to that of the control group.

Conclusion: The results suggest that drug treatment attenuates the alteration of the basal connectivity of RLS patients in some cortical areas, including the Lt. MCC and Rt. PCG. These areas might be related to relieving RLS symptoms with drugs. These findings suggest evidence of alteration in the central processing of RLS symptoms with drug treatment.

0637

BENZODIAZEPINES FOR RESTLESS LEGS SYNDROME: COCHRANE REVIEW

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Introduction: Restless legs syndrome has a major impact on sleep, mostly in the sleep initiation, and benzodiazepines are drugs potentially beneficial to RLS patients. We did a Cochrane systematic review of benzodiazepines for RLS treatment.

Methods: We searched database using the strategy adapted for the Cochrane Collaboration for identification of randomized clinical trials: MEDLINE (1966 to October 2013), EMBASE (1980 to October 2013), LILACS (1982 to October 2013) and Cochrane Central Register of Controlled trials CENTRAL (October 2013). A detailed search strategy was developed to each database and all languages were considered. We included only randomized clinical trial of benzodiazepines treatment in idiopathic RLS.

Results: 1505 titles were retrieved. 576 were about RLS but only two studies (Montagna, 1984; Boghen, 1986) were included, and a total of 12 patients were treated in a crossover design. The drug used was clonazepam in both studies. We did not find differences for: Leg paresthesia (clonazepam: 2.57 \pm 1.02; placebo: 1.90 \pm 1.04; mean difference: 0.67 [95%CI -4.50 to 1.84]); Leg discomfort (clonazepam: 1.46 \pm 1.18; placebo: 1.89 \pm 1.55; mean difference: -0.43 [95%CI -1.99 to 1.13]). A metanalysis for RLS symptoms showed no difference (clonazepam: 2.01 \pm 1.2; placebo: 1.89 \pm 1.26; mean difference: 0.28 [95%CI -0.66 to 1.21]). Sleep quality also did not showed difference between groups (clonazepam: 3.26 \pm 1.03; placebo: 2.49 \pm 0.81; mean difference: 0.93 [95%CI -0.12 to 1.98]).

Conclusion: This systematic review shows that there is no data supporting a rational indication to prescribe clonazepam to treat symptoms of RLS. Data available from the studies showed that the drug is not effective, but this conclusion was based in a very small number of participants. Furthermore other potential bias involving randomization, allocation concealment and blinding of participants and personnel weaken all results presented. The role of benzodiazepines in the treatment of RLS is still not clear and well-designed studies assessing a large number of patients must be done.

Support (If Any): CAPES.

0638

OPIOIDS FOR RESTLESS LEGS SYNDROME

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Introduction: Although opioids seem to be effective to treat RLS symptoms, we did not have any systematic review addressing this intervention in the literature. Objective: To assess the effects of opioid treatment for RLS.

Methods: We searched randomized clinical trial of opioid treatment for idiopathic RLS according to the Cochrane Collaboration strategy.

Results: Data are showed as drug versus placebo. Four randomized clinical trials using opioids (oxycodone, prolonged release oxycodone-naloxone, and propoxyphene) versus placebo satisfied inclusion criteria ($n = 299$). The primary outcome (severity of symptoms) improved in all trials favoring the drug group. Walters 1993 study showed improvement in Legs sensation (1.29 ± 1.37 ; 2.61 ± 1.15 ; MD: -1.32 [95%CI -2.38 to -0.26]), Restlessness (1.21 ± 1.04 ; 2.58 ± 1.17 ; MD: -1.37 [95%CI -2.30 to -0.44]). Kaplan 1993 study showed improvement in Legs activity (4.23 ± 0.68 ; 7.25 ± 1.14 ; MD: -3.02 [95%CI -4.08 to -1.96]). In the study by Trenkwalder, 2013 ($n = 276$) after 12 weeks improvement occurred for Symptoms severity (IRLSSS): 15.1 ± 10.6 ; 22.1 ± 12.2 ; -7.0 (95%CI -9.69 to -4.31), Severity of disease: 2.99 ± 1.48 ; 4.10 ± 1.71 ; MD: -1.11 (95%CI -1.49 to -0.73), and Therapeutic effect: 1.73 ± 1.04 ; 2.75 ± 1.29 ; MD: -1.02 (95%CI -1.30 to -0.74). Meta-analysis showed drug versus placebo superiority for the following secondary outcomes: PLMS index (MD: -28.4 [95%CI -43.76 to -13.03]); Sleep efficiency (MD: -15.69 [95%CI: 7.22 to 24.15]); and Percent of REM (MD: 4.36 [95%CI 1.19 to 7.52]). Side effects were reported by Trenkwalder, 2013 ($n = 304$) in 84% of patients in drug group and 69% patients in placebo group (Risk ratio: 1.22 (95%CI 1.07 to 1.39)). Most important side effects were gastrointestinal problems, fatigue, and headache. Risk of bias included blinding of participants in two studies and attrition bias in another.

Conclusion: Opioids seem to be effective and safe to treat RLS symptoms. Problems with opioids use include gastrointestinal adverse events. Although side effects were observed, there was no report of augmentation.

Support (If Any): Capes, Fapesp 16758-4.

0639

WILLIS-EKBOM DISEASE/RESTLESS LEGS SYNDROME SIGNIFICANTLY IMPACTS PATIENTS' SLEEP, ACTIVITIES AND EMOTIONAL HEALTH: RESULTS OF THE "PATIENT ODYSSEY" SURVEY

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Introduction: Willis-Ekbom Disease/Restless legs syndrome (WED/RLS) is a common neurological disorder that affects 7-10% of the U.S. population. The "Patient Odyssey" survey was designed to assess the day-to-day impact of WED/RLS on patients and their spouses/partners. The survey examined the disease's impact on lifestyle, emotional health and relationships.

Methods: The survey was sent to more than 3,000 members of the Willis-Ekbom Disease Foundation who reported a WED/RLS diagnosis. Recipients also received companion surveys to provide to their spouses/partners. 1,622 adult patients (70% women; 30% men) responded, either online or by mail. The survey was fielded from October 7-November 8, 2013. Only complete surveys were considered.

Results: The results of the patient survey demonstrate that WED/RLS significantly impacts patients. Eighty-five percent of patients report WED/RLS disturbing their ability to have a restful night, 53% report sleep disruption 4 or more nights/ week, and 58% report that they lose 3 or more hours per affected night. As a result of their sleep loss, 61% of patients report their productivity being at least moderately impacted the following day. The survey also revealed that patients altered the way they sleep (62%), travel (55%), and socialize (45%). Mood is affected as 37% of patients report that the disease distresses their mood and overall happiness. Possibly contributing to their dissatisfaction, 86% of patients believe WED/RLS is trivialized and 45% wish their family and friends were more supportive.

Conclusion: The survey demonstrates that WED/RLS degrades patients' sleep quality, activities of daily living, and emotional health, necessitating lifestyle adaptations. The results also emphasize the need to bridge the current educational gap on WED/RLS to improve patient outlook on their disease.

Support (If Any): This project was supported by a grant from XenoPort, Inc.

0640

BURDEN ON THE FAMILY OF PATIENTS WITH WILLIS-EKBOM DISEASE/RESTLESS LEGS SYNDROME: RESULTS FROM THE "PATIENT ODYSSEY" SURVEY

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Methods: The survey was sent to more than 3,000 members of the Willis-Ekbom Disease Foundation who reported a WED/RLS diagnosis. Recipients also received companion surveys to provide to their spouses/partners. 1,622 adult patients (70% women; 30% men) and 676 adult spouses/partners (65% men; 35% women) responded to the survey, either online or by mail. The survey was fielded from October 7-November 8, 2013. Only complete surveys were considered.

Results: The results of the companion survey demonstrate that partners/spouses are significantly impacted by their spouse's/partner's WED/RLS. Ninety percent of respondents have been in this same relationship for fifteen or more years, of which 51% experience the patient's WED/RLS symptoms daily. WED/RLS particularly affects the sleeping habits of spouses/partners: 38% report impaired ability to have a restful night's sleep and 36% admit sleeping in a separate bed to avoid sleep disturbances. WED/RLS also affects the ability to enjoy leisurely activities as a couple; 28% of spouses/partners report adjusting their social activities and events and 22% avoid plane travel, and 36% avoid car travel. Other areas negatively impacted among some respondents include mood/happiness and performance.

Conclusion: The survey demonstrates that WED/RLS negatively impacts spouses/partners, especially sleep and ability to travel. The results indicate that patients and their spouses/partners require ongoing support to help them better manage the disease together and ultimately lessen the burden they experience as a couple.

Support (If Any): This project was supported by a grant from XenoPort, Inc.

0641

PATIENT REPORTED RESPONSE TO TREATMENTS FOR WILLIS EKBOM DISEASE/RESTLESS LEGS SYNDROME: RESULTS OF THE “PATIENT ODYSSEY” SURVEY

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Introduction: Willis-Ekbom Disease/Restless legs syndrome (WED/RLS) is a common neurological disorder that affects 7-10% of the U.S. population. The “Patient Odyssey” survey was designed to assess the day-to-day impact of WED/RLS on patients and their spouses/partners. The survey examined treatment history in an effort to quantify potential challenges in long-term disease management.

Methods: The survey was sent to more than 3,000 members of the Willis-Ekbom Disease Foundation who reported a WED/RLS diagnosis. 1,622 adult patients (70% women; 30% men) and 676 adult spouses/partners (65% men; 35% women) responded to the survey, either online or by mail. The survey was fielded from October 7-November 8, 2013. Only complete surveys were considered.

Results: The results of the patient survey show that WED/RLS in this cohort was fairly severe, with 73% experiencing daily symptoms and 85% reporting impaired sleep. The most common current medications are pramipexole (39%), ropinirole (31%), opioids (20%) and gabapentin (19%). Only 6% consider their symptoms fully controlled, 45% usually controlled, and 47% somewhat or not controlled. 31 percent of patients report that they have switched prescription medication three or more times, most commonly due to poor nighttime symptom control (46%), side effects (23%), and earlier onset symptoms (21%). Response consistent with augmentation was reported by 68%, and usually necessitated medication adjustment. Non-prescription and alternative medicines have been tried by 67%. Patients were often unsatisfied with their physicians’ knowledge of, and ability to treat WED/RLS.

Conclusion: The survey demonstrates that WED/RLS represents a considerable burden on patients as they struggle to control their symptoms. The survey results indicate the need for greater physician awareness of alternate treatment options, as well as the need for continued discussions between physicians and their patients about long-term WED/RLS disease management.

Support (If Any): This project was supported by a grant from XenoPort, Inc.

0642

CARDIOVAGAL BAROREFLEX GAIN IS REDUCED IN PATIENTS WITH RESTLESS LEGS SYNDROME

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Introduction: Restless legs syndrome (RLS) is associated with higher prevalence of hypertension and incident coronary heart disease. The arterial baroreflex is a primary regulator of cardiovascular autonomic control and low cardiovagal baroreflex gain is a prognostic indicator for increased cardiovascular morbidity and mortality. Therefore, we examined arterial baroreflex gain in participants with and without RLS.

Methods: We determined cardiovagal baroreflex gain in normotensive patients with RLS (n = 10, 8 female) who were either untreated (4/10) or washed out of RLS medications (6/10) for 36 hours, and non-RLS controls (n = 6, 4 female). Blood pressure and EKG were recorded continuously during two trials of sequential injections of nitroprusside and phenylephrine (modified Oxford technique). Systolic blood pressure was determined from the maximum pressure waveform and R-R intervals

from the period between successive R waves. We derived baroreflex gain from the linear relation of R-R interval to systolic blood pressure during the pressure rise. Using piecewise linear regression, we calculated individual cardiovagal baroreflex gains, and weighted each participant’s two gains by R2 for an overall gain. We compared weighted gains between RLS and controls via repeated measures ANOVA, accounting for sex, age, and BMI.

Results: Patients with RLS (mean age = 44, range 28-61 years) had moderate RLS symptoms (mean IRLS score 18.8 ± 10.9). The controls’ mean age was 38 (range 27-48 years). Baseline blood pressures and heart rate were similar in both groups. Patients with RLS had a significantly lower baroreflex gain compared with controls (14.6 ± 6.5 vs 19.5 ± 6.9 msec/mmHg, p = 0.035), which remained significant even after accounting for sex, age and BMI (all p < 0.05).

Conclusion: Impaired control of cardiovagal baroreflex gain may be one pathway by which RLS increases cardiovascular risk. Further research is needed to explore whether treatment of RLS improves cardiovascular control.

Support (If Any): UCB Pharma 2012-CNS-85.

0643

CHANGE IN HEART RATE VARIABILITY PRECEDES THE OCCURRENCE OF PERIODIC LEG MOVEMENTS DURING SLEEP: AN OBSERVATIONAL STUDY

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Introduction: Several reports have described that individual periodic leg movements during sleep (PLMS) activities are associated with increased sympathetic nervous activity occurring shortly before each PLMS activity. Nevertheless, no study has investigated dynamic changes of autonomic nervous system activity at the transition from the PLMS free period to the initiation of the period with frequent PLMS. This study was set out to detect the changes in heart rate variability (HRV) at the onset of the period with PLMS using complex demodulation method.

Methods: This study enrolled 14 patients diagnosed as having idiopathic PLMS disorder (PLMD). In periods with and without PLMS during sleep stage 2, HRV-related variables and the spectral power of fluctuation of a high frequency (HF) band (FHFB) were analyzed and compared between these two periods. The changes of those parameters during transition from the period without PLMS to that with PLMS were explored.

Results: Spectral power in the low frequency (LF) band and very low frequency (VLF) band were higher in the period with PLMS. Additionally, the average frequency in FHFB was higher. The frequency in this band fluctuated during the period with PLMS with remarkable elevation of FHFB. Moreover, spectral powers in FHFB, LF, and VLF were remarkably elevated shortly before the beginning of the period with PLMS (FHFB, -65 s; LF, -53 s; and VLF, -45 s).

Conclusion: Not only sympathetic hyperactivity, but also fluctuation of parasympathetic nervous activity occurred several tens of seconds before the beginning of the period with PLMS. These dynamic changes in the autonomic nervous system activity that occur before the beginning of the period with PLMS are inferred to be related with the mechanism of PLMS occurrence.

0644

AUTONOMIC DYSFUNCTION IN RAPID EYE MOVEMENT SLEEP WITHOUT ATONIA

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Introduction: Autonomic dysfunction has been demonstrated in patients with rapid eye movement sleep behavior disorder utilizing heart rate variability parameters. We hypothesized that isolated rapid eye movement sleep without atonia is similarly associated with autonomic dysfunction as demonstrated by a reduction in heart rate variability.

Methods: An evaluation of 120 records demonstrating rapid eye movement sleep without atonia during polysomnography was performed. Several records (n = 99) were discarded owing to factors potentially affecting heart rate variability. The remaining 21 records were age- and sex-matched with 21 controls and subjected to electrocardiogram analysis. The parameters measured included R wave to R wave interval (RR) length, RR standard deviation, heart rate variability power, and very low frequency, low frequency, and high frequency bands.

Results: Autonomic dysfunction was seen in patients with rapid eye movement sleep without atonia as denoted by a reduction in heart rate variability compared to controls. Significant differences between the groups were demonstrated in RR standard deviation (mean difference = 0.1502 ± 0.317 , 95% confidence interval [95%CI] = 0.006, 0.295, p = 0.042), heart rate variability power (mean difference = 0.3005 ± 0.635 , 95%CI = 0.011, 0.589, p = 0.042), and low frequency (mean difference = 0.3166 ± 0.616 , 95%CI = 0.036, 0.597, p = 0.029) and high frequency bands (mean difference = 0.3121 ± 0.686 , 95%CI = -0.000, 0.624, p = 0.050).

Conclusion: Our data confirms the hypothesis that heart rate variability is reduced in patients with isolated rapid eye movement sleep without atonia. The values obtained are consistent with previous findings in rapid eye movement behavior sleep disorder patients. This is the first report of autonomic dysfunction in isolated rapid eye movement sleep without atonia, revealing the need for further evaluation of the clinical significance and potential implications of this finding.

0645

VIBRATION AND SKIN BLOOD FLOW CHANGES IN SUBJECTS WITH RLS

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Introduction: Vascular disturbances leading to tissue hypoxia have been named as one of possible causes for RLS. Vibration to the whole body (WBV) in healthy individuals results in nitric oxide (NO) generation, which then leads to increased blood flow. The purpose of this investigation was to determine if WBV will 1) improve skin blood flow, as measured in flux, in individuals with RLS and 2) induce increases in NO blood concentration. The data were compared to healthy age-matched subjects.

Methods: Ten subjects with primary RLS (age 44.6 years, SD 13.6; M:F ratio 1:1; years since RLS diagnosis 11.3, SD 4.3; IRLS score 19.7, SD 7.5; subjects on RLS medication 3) and 10 healthy controls (age 43.8 years, SD 15.3; M:F ratio 1:1) underwent one 10-bout, 30-second WBV and one sham treatment session. Flux measurements with laser Doppler and blood draws were performed before, immediately after and 5 minutes after the sessions.

Results: Baseline flux was significantly higher in the RLS group compared to control (p < 0.001); flux in the RLS group immediately after WBV was significantly higher compared to baseline, sham treatment

and compared to control group. There was no difference in NO concentration within subjects and between groups.

Conclusion: This study has shown that subjects with RLS have increased pedal skin blood flow and react significantly differently with vasodilation to whole body vibration than subjects without RLS. This suggests a possible association between RLS and blood flow control.

0646

PERIODIC LIMB MOVEMENTS IN PATIENTS UNDERGOING ADAPTIVE SERO-VENTILATION TITRATION

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Introduction: Periodic limb movements in sleep (PLMS) are frequently observed in patients being evaluated for sleep-disordered breathing. PLMs are also found in systemic diseases such as congestive heart failure, hypertension, and stroke. Patients who undergo adaptive servo-ventilation (ASV) therapy often have cardiovascular disease. We hypothesized that there would be a high prevalence of periodic limb movements in patients who had ASV studies.

Methods: A retrospective chart review of all patients who underwent an overnight ASV polysomnogram at a large university sleep center over a one-year period was conducted. In addition, each patient's diagnostic study was reviewed. The AASM scoring guidelines were used and PLMS were defined as > 5 per hour. Statistical analysis was done using paired t-test.

Results: A total of 53 subjects underwent an ASV polysomnogram. The most common diagnosis was complex sleep apnea (44%) followed by mixed sleep apnea (28%) and central sleep apnea (28%). There was a male predominance (85%) with a mean age of 64.6. The baseline PLMI was 13.6 and the baseline RDI was 57.1, compared to a PLMI of 27.4 and a RDI of 10.7 on the ASV study. 17 subjects had PLMS on their baseline study (mean = 35.8 ± 33.8), while 25 had PLMS on their ASV study (53.9 ± 42.8). 14 patients had PLMS on both studies (baseline = 37.9 ± 36.7 ; ASV = 58.7 ± 46.7). There was no statistically significant difference between the baseline PLMI and the ASV study PLMI.

Conclusion: PLMS are common in patients who undergo ASV studies. Although the significance of PLMS is not well understood, the interplay between the underlying physiology of these movements with systemic disease and various therapeutic options needs to be further studied.

0647

EFFECTS OF ROTIGOTINE ON PERIODIC LIMB MOVEMENT (PLM) INDEX WITH SYSTOLIC BLOOD PRESSURE ELEVATIONS AND PLM AROUSALS IN PATIENTS WITH RESTLESS LEGS SYNDROME (RLS)

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Introduction: Periodic limb movements (PLM) during sleep are associated with significant blood pressure (BP) elevations in patients with RLS, particularly when PLM are accompanied by arousals. These transient BP excursions may convey an increased risk of hypertension and cardiovascular disease. Effects of rotigotine on PLM with and without systolic BP (SBP) elevations, and on PLM with arousals were investigated in patients with RLS.

Methods: This double-blind study (SP0977; ENCORE [NCT01455012]) randomized patients with idiopathic RLS (IRLS ≥ 15) to optimal dose rotigotine (1-3 mg/24 h) or placebo (1:1). Continuous beat-by-beat BP and heart rate assessments were performed at baseline and end of 4-week

maintenance (EoM). Outcome measures included change from baseline to EoM in PLM index with (PLMI_{SBPE}) and without (PLMI_{NSBPE}) SBP elevations (defined: slope of linear regression ≥ 2.5 over 5 consecutive heartbeats [equivalent to ≥ 10 mmHg]), and in number of PLM arousals (prospectively collected, retrospectively analyzed). Data are reported for the full analysis set (FAS).

Results: 66 patients (rotigotine: 37; placebo: 29) comprised the FAS. Reductions from baseline in PLMI_{SBPE} (baseline mean [SD] for rotigotine: 40.2 [36.1]; placebo 38.9 [28.8]) were greater for rotigotine than placebo (LS mean [SE] -31.62 [2.31] vs -11.42 [2.58]; LS mean treatment difference [95% CI]: -20.20 [-27.09, -13.31], $p < 0.0001$). Rotigotine-treated patients also had greater reductions vs placebo in PLMI_{NSBPE} (-17.57 [2.25] vs -5.39 [2.52]; treatment difference: -12.17 [-18.90, -5.45]; $p = 0.0006$). Greater reductions from baseline were observed for rotigotine vs placebo in the LS mean (SE) number of PLM episodes with arousals (-64.0 [6.14] vs -24.85 [6.88]; difference: -39.15 [-57.50, -20.79]; $p < 0.0001$) and without arousals (-206.51 [18.72] vs -54.03 [20.98]; difference: -152.48 [-208.42, -96.54], $p < 0.0001$).

Conclusion: Rotigotine reduced PLM in patients with and without SBP elevations, and PLM arousals in patients with RLS, suggesting that rotigotine may reduce nocturnal BP elevations via its effect on PLM. Additional studies are needed to determine the effects of PLM reductions on cardiovascular risk.

Support: This study was supported by UCB Pharma, Smyrna, GA, US.

0648

RESTLESS LEGS SYNDROME AND PULMONARY HYPERTENSION

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Introduction: Restless legs syndrome (RLS) is a debilitating disorder characterized by a deep-seated unpleasant sensation in the legs. RLS can be either idiopathic or associated with a variety of underlying medical conditions. Little is known regarding the frequency of RLS among patients with pulmonary hypertension (PH). Our study purpose is to estimate the prevalence of RLS in our PH population.

Methods: We conducted a retrospective chart review of the patients seen in PH clinic, Mayo Clinic, Florida from 2010-2012. The patients were contacted by mail to complete the Cambridge-Hopkins Restless Legs Syndrome questionnaire. The questionnaire consists of 13 items, which cover essential and supportive criteria to diagnose RLS. Demographic data, PH diagnostic group, WHO functional class, hemodynamic data, blood tests including BNP, CBC, and creatinine were collected and analyzed.

Results: A total of 57 patients were included. The prevalence of RLS was 12.3%. Most of the patients were female (48/57, 84%). Mean age was 67 years old (32-86, SD 12.5). MPAP (44/57) was 42.6 mmHg (10-71, SD 14). Mean 6 minute walk distance (48/57) was 369 meters (115-741, SD 105.25). Patients was diagnosed with Group 1 pulmonary artery hypertension in 45/57, 79%, Group 2 pulmonary venous hypertension 5/57, 9%, Group 3 PH associated with lung disease 1/57, 2%, Group 4 CTEPH, 4/57, 7%, and PH due to multiple factors 2/57, 3%. Of these, 6/7 patients with RLS were in Group 1 PH. Most of the patient had functional class 3 (38/57, 67%). Only three patients with RLS had anemia. No ESRD patients in our population.

Conclusion: The prevalence of RLS is not increased in patients with PH compared with general population with estimates ranging between 5-24%.

0649

HEART RATE VARIABILITY AND CORTICAL AROUSALS ASSOCIATED WITH PERIODIC LIMB MOVEMENTS IN PATIENTS WITH SPINAL CORD INJURY

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Introduction: Periodic limb movements (PLM) are associated with autonomic lability, as manifest by increased pulse and blood pressure, and cortical arousals. However, the anatomic substrate of any of these, and the relationships among them, parallel, sequential, etc. are not understood. Patients with spinal cord lesions are well documented to have PLM but differences in these subjects, compared to those with intact neuroanatomy, have not been reported.

Methods: We identified subjects with complete spinal cord lesions (SCL) who exhibited PLM during routine polysomnography and compared them to an age/sex matched group of subjects with PLM, but without SCL with regard to differences in pulse changes and arousals. All patients were referred for suspicion of sleep-disordered breathing. Polysomnograms were recorded and scored according to AASM 2007 guidelines. RR interval was used to measure heart rate. 10 PLMs in each patient were analyzed, all in NREM sleep, to avoid sleep stage influence. Heart rate changes within the two groups were compared using the paired t-test. Percentages of PLM associated with cortical arousals were also compared.

Results: Preliminarily, 3 male patients with SCL and PLM (Group SCL) showed a 6.9% increase in pulse compared to a 10.7% increase in 3 matched patients without SCL, but with PLM (Group nSCL). Although there was a trend for less relative tachycardia in the SCL group, it was not statistically significant ($p = 0.10088$). Similarly, statistically significant differences were not seen in percentages of PLM causing cortical arousals between the two groups (5.08% SCL vs. 15.25% nSCL, $p = 0.20$).

Conclusion: Relative tachycardia in subjects with spinal cord lesions was still present. This suggests that the autonomic lability, at least pulse, can be generated within the spinal cord, or less likely from the physical movement itself. Cortical arousals are still often present suggesting that a direct neurologic connection between alpha-motor-neuron and cortex is not necessary for this event.

0650

EPIDEMIOLOGY AND RISK FACTORS FOR RESTLESS LEGS SYNDROME: A SINGLE CENTER EXPERIENCE IN THAILAND

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Introduction: Restless legs syndrome (RLS) is a common but frequently undiagnosed sensorimotor disorder. Several clinical and laboratory factors were inconsistently reported to correlate with RLS. There has been no published data available on RLS situation in Thailand. We aim to assess the prevalence of RLS and associated clinical conditions in Thailand.

Methods: All adult participants (age > 15 years) underwent polysomnogram (PSG) of any reasons at Excellence Center for Sleep Disorders, King Chulalongkorn Memorial Hospital between January 2009 and December 2011 were retrospectively reviewed consecutively. Demographic characteristic, associated diseases, medications were recorded and analyzed. RLS was diagnosed according to criteria endorsed on the International Classification of Sleep Disorders, version 2 (ICSD-2). Sig-

nificant periodic limb movements (PLM) are defined by an increased PLM ≥ 15 per hour of sleep. Data shown as mean \pm S.D. and p-value less than 0.05 defined as significance.

Results: 988 participants who completed a night pre-sleep questionnaire (631 male and 357 female) were enrolled. The overall prevalence of RLS was 16.9% (58% female). The mean age was 54.26 ± 13.34 years (range 18 to 82 years old). The associated conditions consisted of hypertension (OR 1.51 [95%CI 1.03-2.19]), diabetes mellitus (OR 1.78 [1.10-2.86]), and iron deficiency anemia (8.13 [0.90-73.30]); $p < 0.05$ for all. After adjusting for confounders, multivariate analysis identified only iron deficiency anemia (IDA) as risk factor for RLS. Polysomnogram revealed significant PLM in 54.4% of RLS patients.

Conclusion: The study demonstrated that RLS is common in Thai patients. It may be a primary condition, or it may be associated with hypertension, DM and iron deficiency anemia. IDA seems to be the most important risk factor for RLS. Periodic leg movements during the night may be one of helpful warning symptoms for RLS.

0651

GENETIC ASSOCIATION ANALYSIS BETWEEN MEIS1, BTBD9 AND MAP2K5/LBXCOR1 POLYMORPHISMS AND RESTLESS LEGS SYNDROME SYMPTOMS IN A POPULATION BASED SAMPLE FROM SÃO PAULO, BRAZIL

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Introduction: Restless legs syndrome (RLS) is a disorder characterized by an urge to move legs during periods of rest, especially at night, associated to unpleasant sensations in the lower limbs, which may lead to disturbed sleep. Recent genome-wide association studies have been conducted to find common variants associated to RLS and allowed the identification of three candidate regions containing the genes MEIS1, BTBD9 and MAP2K5/LBXCOR1, located on chromosomes 2p, 6p and 15q. The present study aimed to replicate the associations between three single nucleotide polymorphisms (MEIS1 rs2300478; BTBD9 rs3923809 and MAP2K5/LBXCOR1 rs6494696) with RLS symptoms in a large population-based sample from São Paulo, Brazil.

Methods: Nine-hundred and eighty individuals participating in the Epidemiologic Sleep Study of São Paulo were subjected to an extensive sleep survey and full-night polysomnography. RLS symptoms (presence and frequency of leg discomfort) were subjectively evaluated with questionnaires. Genotyping of the three polymorphisms and a set of 31 genetic ancestry informative markers was carried out by allele-specific polymerase chain reaction.

Results: Significant associations between MAP2K5/LBXCOR1 rs6494696 and presence of leg discomfort were found ($p = 0.002$). The frequency of GG genotype was higher among individuals complaining of leg movement discomfort than those without complains (crude OR for GG versus GC+CC carriers = 1.49; 95%CI = 1.12-1.98). No significant trends were found when the frequency of the symptoms was analyzed. When results were adjusted for age, sex, European genetic ancestry, body mass index, iron and ferritin serum levels, the association between GG genotype and presence of leg discomfort remained significant, with no changes in its magnitude (adjusted OR = 1.49; 95%CI = 1.12-1.98). No significant associations were found for the other studied variants.

Conclusion: The replication of an independent association between MAP2K5/LBXCOR1rs6494696 polymorphism and RLS symptoms in a population with a different genetic background supports the role of this locus in the physiopathology of RLS.

Support (If Any): AFIP, FAPESP, CAPES, CNPq.

0652

DQB1 LOCUS ALONE EXPLAINS MOST OF THE RISK AND PROTECTION IN NARCOLEPSY WITH CATAPLEXY IN EUROPE

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Introduction: Prior research has identified five common genetic variants associated with narcolepsy with cataplexy in Caucasian patients. To replicate and/or extend these findings, we have tested HLA-DQB1, the previously identified 5 variants, and 10 other potential variants in a large European sample of narcolepsy with cataplexy subjects.

Methods: A recent study showed that over 76% of significant genome-wide association variants lie within DNase I hypersensitive sites (DHSs). From our previous GWAS, we identified 30 single nucleotide polymorphisms (SNPs) with $P < 10^{-4}$ mapping to DHSs. Ten SNPs tagging these sites, HLA-DQB1, and all previously reported SNPs significantly associated with narcolepsy were tested for replication. For GWAS, 1261 narcolepsy patients and 1422 HLA-DQB1*06:02-matched controls were included. For HLA study, 1218 patients and 3541 controls were included.

Results: None of the top variants within DHSs were replicated. Out of the five previously reported SNPs, only rs2858884 within the HLA region ($P < 2 \times 10^{-9}$) and rs1154155 within the TCA locus ($P < 2 \times 10^{-8}$) replicated. DQB1 typing confirmed that DQB1*06:02 confers an extraordinary risk (odds ratio 251). Four protective alleles (DQB1*06:03, odds ratio 0.17, DQB1*05:01, odds ratio 0.56, DQB1*06:09 odds ratio 0.21, DQB1*02 odds ratio 0.76) were also identified.

Conclusion: An overwhelming portion of genetic risk for narcolepsy with cataplexy is found at DQB1 locus. Since DQB1*06:02 positive subjects are at 251-fold increase in risk for narcolepsy, and all recent cases of narcolepsy after H1N1 vaccination are positive for this allele, DQB1 genotyping may be relevant to public health policy.

Support (If Any): The study was largely funded by the University of Lausanne and partly supported by a European Narcolepsy Network (EU-NN) grant to M. Tafti. Additional support for this research was provided by the French Ministry of Research and Higher Education, Project Agence Nationale de la Recherche-07-MRAR (France), PHRC 2007-P070138 (France).

0653

CD4⁺ T-CELL AUTOIMMUNITY TO HYPOCRETIN/OREXIN IN NARCOLEPSY

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Introduction: Narcolepsy Type 1 is characterized by excessive daytime sleepiness, cataplexy, and Rapid Eye Movement (REM) sleep

abnormalities. It is caused by the loss of ~70,000 posterior hypothalamic neurons that produce the wake-promoting neuropeptide hypocretin (orexin). An autoimmune basis for narcolepsy has long been suspected on the basis of a strong association with Human Leukocyte Antigen (HLA)-DQA1*01:02-DQB1*06:02 (DQ0602). To investigate this, we sought to identify DQ0602-presented epitopes in hypocretin that could activate CD4⁺ T-cells in blood samples from patients with narcolepsy.

Methods: Overlapping 15-mer peptides covering the entire prepro-HCRT protein were screened for their ability to compete with an EBV epitope for DQ0602 binding in a peptide binding competition assay. Reactivity of CD4⁺ T-Cells towards hypocretin epitopes were then assessed by IFN γ ELISpot assays using antigen presenting cells expressing only DQ0602. Samples included 23 patients with Type 1 narcolepsy and 24 age and gender-matched DQ0602-positive controls. We also included four monozygotic twin pairs discordant for narcolepsy Type 1, and 10 Irish children who developed narcolepsy after Pandemrix influenza vaccine and 7 unaffected siblings (DQ0602-positive, Pandemrix vaccinated).

Results: We found 5 strong DQ0602 binders from prepro-HCRT, including a previously reported DQ0602-binding peptide located in the N-terminal leader peptide of prepro-HCRT. Among these were also the C-terminal ends of the two secreted hypocretin peptides: HCRT₅₆₋₆₈ and HCRT₈₇₋₉₉. In 33 out of 37 patients, we found strong CD4⁺ T-cell reactivity to HCRT₅₆₋₆₈ and HCRT₈₇₋₉₉. In contrast, samples from DQ0602-positive controls did not react. Within each pair of twins, HCRT₅₆₋₆₈ and HCRT₈₇₋₉₉ reactivity was observed only in the affected twin. Reactivity to the HCRT₅₆₋₆₈ and HCRT₈₇₋₉₉ epitopes was elevated in the 10 Irish children who developed narcolepsy after Pandemrix influenza vaccine but not their unaffected siblings.

Conclusion: These data demonstrate for the first time that T-cell auto-reactivity towards hypocretin epitopes presented by DQ0602 is present in Type 1 narcolepsy.

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0654

PHYSIOLOGICAL SLEEP PROPENSITY AND DEPRESSION AS PREDICTORS OF INCIDENT EXCESSIVE DAYTIME SLEEPINESS

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Introduction: Excessive daytime sleepiness (EDS) is highly prevalent and is associated with significant personal dysfunction and occupational and public safety hazards. Current nosologies view hypersomnia disorders as comorbid with mental health disorders; however, whether the development of EDS in individuals with and without a history of depression is associated with specific premorbid polysomnographic (PSG) predictors remains unknown.

Methods: 1,173 adults (age 20-88 y) without EDS from the Penn State Adult Cohort were studied in the sleep laboratory at baseline and followed-up after an average of 7.5 years. Logistic regression models were used to examine the association of depression, PSG parameters, and their interaction with incident EDS, while controlling for gender, age, race, obesity, sleep apnea, diabetes, hypertension, and sleep complaints.

Results: Depression ($p < .001$), PSG markers of sleep fragmentation [i.e., increased number of wakes ($p = .008$) and percent of stage 1 ($p < .01$) and decreased percent of stage 2 ($p < .05$) and slow wave sleep ($p < .10$)], and of increased sleep propensity [i.e., sleep latency ≤ 7 min ($p < .01$)], were significantly associated with incident EDS. Significant interactions between depression and PSG parameters on incident EDS showed that depressed individuals with incident EDS slept poorly at baseline (e.g., increased sleep latency, wakefulness after sleep onset, etc.), while non-depressed individuals with incident EDS had increased physiologic sleep propensity at baseline (e.g., decreased sleep latency, increased total sleep time, etc.).

Conclusion: Our data suggest two major pathways leading to increased risk for incident EDS. One is through depression and the other is through increased physiological sleep propensity, most likely biologically driven. These differential pathophysiologic mechanisms have important diagnostic and treatment implications. Depression-driven EDS may respond better to psychiatric or behavioral interventions, whereas physiological driven EDS may respond better to pharmacological interventions, i.e. stimulants.

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0655

HYPERSOMNIA IN BIPOLAR DISORDER: CLARIFYING A DIAGNOSTIC DILEMMA

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Introduction: Hypersomnia in psychiatric disorders is poorly defined, though evidence suggests it is associated with a range of negative health outcomes and increased new-onset and recurrence of psychiatric illness. Lack of definition impedes generalizability across research studies. We examined the possibility of hypersomnia subgroups, along with their relationship to prospective sleep data and relapse into psychiatric illness, in a sample of individuals with bipolar disorder.

Methods: The study included 159 adults with DSM-IV determined bipolar spectrum disorder (I, II and NOS), all euthymic at study entry. Validated self-report measures and clinician-administered interviews determined features of hypersomnia, including habitual sleep duration, excessive sleepiness, and napping. Participants completed sleep diaries and wore wrist actigraphy to obtain prospective data, including total sleep time (TST) and time in bed (TIB), in the home environment. Follow-up interviews were completed seven months later and psychiatric status was re-assessed using the SCID.

Results: Factor analyses of self report and clinician-administered interviews confirmed two separate subtypes of hypersomnia—a group characterized by long self-reported sleep time and a group characterized by self-reported excessive sleepiness—that were uncorrelated ($r = -.09$). Latent class analyses suggested a four-class solution best characterized the data, with long sleep and excessive sleepiness representing two separate classes. Structural equation modeling (SEM) results indicated that the sleep of ‘long sleepers’ was characterized by long TIB, not long TST. Finally, SEM analyses suggested that excessive sleepiness at baseline predicted mania/hypomania relapse at follow-up. Medication use did not appear to influence findings.

Conclusion: This is the largest investigation of psychiatric hypersomnia to include objective measurement of sleep, and refines our understanding of classification, characterization and associated morbidity. Hypersomnia appears to be comprised of two separate subgroups, long sleep and excessive sleepiness. Understanding these entities has important research and treatment implications.

0656

CSF NEUROENDOCRINE REGULATORY PEPTIDE (NERP)-2 LEVELS ARE POSITIVELY CORRELATED WITH OREXIN (HYPOCRETIN) LEVELS.

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Introduction: Neuroendocrine regulatory peptide (NERP)-1 and NERP-2 are derived from distinct regions of VGF, a neurosecretory protein. Vgf^{-/-} mice exhibit dwarfism and hypermetabolic rates, suggesting that VGF or VGF-derived peptides play important roles in energy metabolism. NERPs are abundant in the paraventricular and supraoptic nuclei and colocalized frequently with vasopressin (Yamaguchi2007). NERP-2 expression also localized to the lateral hypothalamus and the dorsomedial perifornical hypothalamus, colocalizing with orexins (Toshinai2010). NERP-2 administration induced Fos protein, a marker of neuronal activation in the orexin-immunoreactive neurons. Icv administration of NERP-2 also increased body temperature, oxygen consumption and locomotor activity in rats. NERP-2 did not induce food intake or locomotor activity in orexin-deficient mice. NERP-2 plays a role in the control of food intake and energy homeostasis via orexin pathway. Thus, it is also important to study the levels of NERP-2 and orexin-A in human CSF. We therefore measured NERP-2 and orexin-A in narcolepsy and other sleep disorders to identify altered NERP-2 levels.

Methods: CSF was collected from patients with narcolepsy and other sleep disorders. NERP-2 and orexin-A were measured using a commercially available radioimmunoassay (RIA) kit (Phoenix Pharmaceuticals, CA). Included disease groups, orexin deficient narcolepsy (n = 6), orexin non-deficient narcolepsy (n = 2), idiopathic hypersomnia (n = 6), symptomatic hypersomnia (n = 4).

Results: The range of NERP-2 levels were 34-133 pg/ml and the mean value was 74.2 ± 29.3 pg/ml (mean \pm SD). Each NERP-2 level was followed, orexin deficient narcolepsy (mean: 74.5 pg/ml), orexin non-deficient narcolepsy (94 pg/ml), idiopathic hypersomnia (81.9 pg/ml), symptomatic hypersomnia (51.7 pg/ml). Since NERP-2 was derived from only paraventricular and supraoptic nuclei, excluding the data with orexin deficient narcolepsy, the positive correlation was found between NERP-2 and orexin (Pearson's correlation, $r = 0.77$, $p = 0.004$, $n = 12$).

Conclusion: The CSF NERP-2 can be measured by using RIA kit, and the positive correlation was found between NERP-2 and orexin-A. Further research is needed for this novel peptide.

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0657

INVESTIGATING THE HYPOCRETIN/OREXIN SPECIFIC T CELL RESPONSE IN PATIENTS WITH NARCOLEPSY WITH CATAPLEXY

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Introduction: Narcolepsy with cataplexy is caused by a selective loss of hypocretin/orexin producing neurons in the lateral hypothalamus. A strong genetic association with HLA DQB1*06:02 is well-known and further genes involved in immune modulation such as T cell receptor alpha, OX40L, cathepsin H, DNMT1 and P2RY11 were shown to be associated with narcolepsy in genome-wide association studies. Although these associations strongly suggest an involvement of immune cells, the contribution of T cells in pathogenesis is largely unknown. The aim of this study is to investigate T cell reactivity in narcolepsy cataplexy patients.

Methods: In total 15 narcolepsy cataplexy patients and 15 age and gender matched controls will be included in this study. Peripheral blood mononuclear cells are stained by CFSE and stimulated with an orexin peptide library. Proliferation of CD3+ and CD4+ cells is determined on day 11 by flow cytometry.

Results: So far, 10 narcolepsy patients (3 women 7 men, mean age 42.8 ± 18.2 years) and 8 age and gender matched healthy controls (2 women, 6 men, mean age 45.5 ± 12.4 years) were included in this study. Four patients (40%) and one control (12.5%) showed orexin specific proliferation of CD3+ CD4+ cells. All four patients had in addition proliferating CD3+ CD4- cells, which were not seen in any of the controls. Six patients and seven controls had no orexin specific T cell reactivity at all.

Conclusion: These preliminary data of this ongoing study may indicate a higher CD3+ cell reactivity to orexin in narcolepsy patients compared to healthy controls. To confirm these results, analysis of cytokine levels in cell culture supernatants (IL10, IL17A, IFN γ and GM-CSF) and testing of further patients and controls is currently being performed.

0658

THE DIAGNOSTIC VALUE OF POLYSOMNOGRAPHIC EEG IN NARCOLEPTICS

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Introduction: Narcolepsy is characterized by instability of the sleep-wake regulation, daytime sleepiness, nocturnal sleep fragmentation and cataplexy caused by hypocretin deficiency. The stage shifts during sleep, and the transitions from sleep into wakefulness require delicate switching mechanisms proposed as two mutually dependent flip-flop switches, where especially hypocretin plays an important role. In this study, polysomnographic (PSG) EEG characteristics of the different sleep stages are investigated in narcoleptic patients and control subjects, in order to assess the diagnostic value of EEG alone.

Methods: The power spectral density (PSD) was computed for the C3-A1 EEG channel from 137 narcoleptic patients and 511 sex- and age-matched control subjects. Features reflecting differences in the PSD between the two groups were computed. In order to identify the most indicative feature subset, a forward feature selection using a Least Squares Support Vector Machine (LSSVM) classifier with a Radial Basis Func-

tion (RBF) kernel was performed using two-fold cross validation. The selection scheme was repeated ten times, and the final feature subset was selected based on how many times each feature was selected across the runs.

Results: The final feature subset included eight features, whereof the most indicative one reflects normalized power in the frequency range 1-7.75 Hz during REM sleep. This feature was selected as the highest ranked one across all ten runs. The remaining features were selected six, five or four times across the ten runs. The final model obtained a mean accuracy of 89.7%, a mean sensitivity of 64.7% and a mean specificity of 96.4%.

Conclusion: Our results suggest that PSD features computed from a central EEG signal can be indicative of narcolepsy. Using a subset of eight features and a LSSVM classifier, a high specificity and a relatively low sensitivity was reached, indicating that EEG characteristics should not stand alone when automatically detecting narcoleptic patients.

0659

CHARACTERISTICS OF NARCOLEPSY ACCORDING TO THE AGE OF DIAGNOSIS

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Introduction: To conduct a descriptive analysis between narcoleptic patients (NC) diagnosed before and after 18 years.

Methods: Data extracted from the National French Multicentre Research Program on narcolepsy and 23 pediatric patients from the Lyon's Center. Clinical and electrophysiological characteristics were compared between de novo patients diagnosed before (n = 59) and after 18 years (n = 108).

Results: Mean ages \pm SD at diagnosis were respectively 11.7 ± 2.9 in pediatric (PP) vs 33.5 ± 14.3 years in adult (AP) patients. Sleepiness appeared earlier in children (10 ± 2.8 vs 25 ± 12.5 years, $p < 0.001$) with a shorter diagnosis delay (1.6 ± 1.5 vs 8.1 ± 11.9 years, $p = 0.01$). Cataplexy were reported in 84% of PP vs 49% of AP ($p < 0.001$). PP had also less sleep paralysis than AP (18.6% vs 42.6% ($p = 0.003$), but no difference for hypnagogic hallucinations (44.1 vs 50.9%). HLA DQB1*0602 was found in 94.9% of the PP vs 54.6% in AP ($p < 0.001$). PP were more frequently obese (61% vs 12.9% ($p < 0.001$)) with earlier puberty (11.5 ± 1.2 vs 13 ± 1.5 years ($p = 0.003$)). On PSG, PP had higher TST ($p = 0.75$), ADHD symptoms were only found in PP (5.13% vs 0%, $p < 0.001$). Depressive feelings were found in 36% of AP vs 30% of PP (NS). However, AP had lower quality of life (QL) than PP (43.7 ± 6.4 vs 61.5 ± 13.5 , $p < 0.001$). QL was affected by depressive feelings ($r = -0.57$, $p < 0.001$), fatigue ($r = -0.43$, $p < 0.001$), age ($r = -0.46$, $p < 0.001$) and obesity (BMI-z) ($r = -0.31$, $p = 0.001$).

Conclusion: The clinical presentation with obesity and ADHD was more marked in NC patients diagnosed during pediatric age, which could explain the short diagnosis delay. However, adult patients had

lower QL than PP patients. We recommend a prompt diagnosis and a more thorough assessment and long term management of psychological health in this population.

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0660

NARCOLEPTIC FAMILY MEMBERS: EVOLUTION OF NARCOLEPSY SYMPTOMS, DIAGNOSIS AND MORTALITY IN A LONGITUDINAL STUDY

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Introduction: Previous genetic studies have shown there is a genetic etiology in narcolepsy-cataplexy. Multiple cases of narcolepsy-cataplexy can be found in only 8%-10% of the families of narcoleptic individuals. It exists however nearly no longitudinal information on the appearance and evolution of narcolepsy symptoms in the probands' families.

Methods: Information on 2,010 individuals was collected: 300 subjects with narcolepsy and 1,710 family members at 3 to 5 year-intervals. In both cases, interviews were conducted by telephone with the Sleep-EVAL system.

Results: At the follow-up, 72 family members were deceased and 37 couldn't be interviewed due to debilitating or terminal disease. At follow-up, 19 family members (7 sons, 3 daughters, 3 sisters, 2 brothers and 4 cousins) developed narcolepsy diagnosed by a sleep specialist for an incidence of 1.2%. A total 50.1% of the family members reported moderate to severe sleepiness at follow-up; 34.2% of the family members reported an increase in their sleepiness but the increase was substantial only for 11.7% of the family members. Most of the family members (87.8%) never experienced sleep paralysis. However, among those who reported it at the initial interview, 57% reported an increase in frequency and 19% a decrease.

Conclusion: Risks for narcolepsy and narcolepsy symptoms are high in family members of narcoleptic individuals. Prevalence of excessive sleepiness is about two times higher in narcoleptic family members compared to the general population.

Support (If Any): Educational grant from Jazz Pharmaceuticals.

0661

NARCOLEPSY IN AFRICAN AMERICANS

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Introduction: Narcolepsy-cataplexy affects 0.03% of the US population and the cause of most cases is a loss of hypocretin/orexin neurons within the hypothalamus, of autoimmune origin. Although narcolepsy affects all ethnic groups, little is known regarding phenotypic expression in various ethnic groups.

Methods: Cases of narcolepsy from 1992 to 2013 with available CSF hypocretin-1 levels were identified from searches conducted in the Stanford Center for Narcolepsy Research database. Information extracted for these patients included demographics, country of origin, ethnicity, clinical

data, HLA DQB1*06:02, polysomnography (PSG) and mean sleep latency test (MSLT) data.

Results: 47 African Americans, 186 Caucasians, 8 Asians and 14 patients with mixed ethnicity with measured CSF hypocretin-1 levels were involved. Age of onset of sleepiness, cataplexy, and hypnagogic/hypnopompic hallucination was earlier in the African American group. HLA DQB1*0602 positivity and % with low CSF hypocretin-1 was significantly higher in African American (93.6%, 89.4%) and mixed ethnicity group (100%, 71.4%) in comparison to Caucasians (68.1%, 52.7%). BMI, sex ratio, ESS score, PSG and MSLT findings did not differ by ethnic groups. In subjects with low CSF hypocretin only however, a larger percent of African American patients reported either no cataplexy or atypical cataplexy.

Conclusion: Narcolepsy in African Americans is characterized by earlier onset of symptoms, higher HLA DQB1*06:02 positive rate and more frequently low CSF hypocretin-1 level in the absence of cataplexy. PSG and MSLT parameters are similar across ethnic groups.

0662

LONG-TERM PROGNOSIS OF NARCOLEPSY

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Introduction: The long-term outcome of the symptoms of narcolepsy is not fully investigated. Some literature mentioned poor prognosis of narcolepsy as an incurable disease. However we observed some narcolepsy patients showed disappearance of narcoleptic symptoms along with their clinical courses. In order to better estimate the prognosis of narcolepsy, we performed survey including those patients who were diagnosed but dropped from medical treatment.

Methods: We performed a questionnaire-based 5-50 year follow-up study on narcolepsy-cataplexy patients who visited our hypersomnia clinic during 1955-2000 and diagnosed by narcolepsy specialists. A questionnaire was sent during September 2006 to November 2007 to a total of 951 eligible narcolepsy patients. Among them, 382 returned the questionnaire and 304 gave a valid response (response rate 32.0%). Their age at investigation was 61.5 ± 14.1, 66% was male and mean follow-up period was 24.7 ± 11.9 years. Frequency of current narcolepsy symptoms were asked under conditions with and without medications. We also asked the symptomatic changes from the conditions of initial hospital visit. In addition to the overall analyses, stratified analyses were performed by subdividing patients into 2 groups; 225 patients who kept visiting hospital (Visiting Group) and 79 patients who stopped going to hospital (Non-Visiting Group).

Results: Marked improvement of excessive daytime sleepiness (EDS) frequency (less than once a month without medication) was observed in 12.4% of patients. Complete remission of cataplexy was observed in 15.2% and marked improvement of frequency (less than once a month) in 34.8%. About half of patients reported subjective improvement of EDS (54.2%) and cataplexy (48.5%) from the initial visit (answers of "marked" and "substantial" improvement were combined). Non-Visiting Group tended to show less frequency of current narcolepsy symptoms compared to Visiting Group. Marked improvement of EDS frequency was observed in 20.8% of Non-Visiting Group compared to 10.2% of Visiting Group (p = 0.10), and that of cataplexy frequency was observed in 60.9% of Non-Visiting Group compared to 28.1% of Visiting Group (p = 0.002).

Conclusion: Complete remission of EDS and cataplexy could occur in narcolepsy and about half of the patients reported symptomatic improvements from the initial hospital visit. In the prognosis study it is important to include patients who stopped visiting hospital for accurate assessment. Further studies are required to find the factors relating to prognosis and

to clarify the mechanism why narcolepsy symptoms could improve under undetectable CSF hypocretin levels.

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0663

SYMPTOMATIC NARCOLEPSY AMONG INHERITED DISORDERS, SUCH AS NIEMANN-PICK TYPE C AND MYOTONIC DYSTROPHY TYPE 1

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Introduction: The symptoms of narcolepsy can occur during the course of other neurological conditions. Inherited disorders, tumors and head trauma were the three most frequent causes for symptomatic narcolepsy. Among inherited disorders, Niemann-Pick type C (NPC), Myotonic dystrophy type 1 (MYD1) and Prader-Willi syndrome were mainly reported. NPC is an autosomal recessive and congenital neurological disorder characterized by the accumulation of cholesterol and glycosphingolipids in the peripheral tissues and of the glycosphingolipids in the brain. Some cases frequently display narcolepsy-like symptoms, including cataplexy. MYD1 is the most common adult-onset form of muscular dystrophy. EDS is the most frequent non-muscular complaint in MYD1. As EDS tends to persist despite successful treatment of SDB in MYD1 patients, available evidence suggests that MYD-related EDS is primarily caused by a central dysfunction of sleep regulation rather than by sleep fragmentation, SDB or PLMS.

Methods: The subjects were 5 patients with NPC (3 male and 2 female) and 11 patients with MYD1 (4 male and 6 female). Patients gave informed consent for the lumbar puncture. We checked clinical symptoms, PSG, MRI/CT and measured orexin levels.

Results: NPC: Two cases were low orexin levels, 2 cases were intermediate, one case was normal. Four subjects having cataplexy had low or intermediate levels. MYD: Orexin levels were decreased to low levels in 3 cases. Four cases were intermediate. Four cases are normal levels. All of them had EDS. PSG result revealed SDB, most patients have complications of severe OSAS.

Conclusion: The degree of reduction among these disorders was small in contrast to idiopathic narcolepsy. Although orexin levels in other genetic neurological conditions without EDS/cataplexy are not systematically studied, further studies of the involvement of the orexin system in symptomatic narcolepsy and EDS are helpful to understand the pathophysiological mechanisms for occurrence of EDS and cataplexy.

0664

PET STUDY OF PEDIATRIC NARCOLEPSY: A PRELIMINARY STUDY

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Introduction: The pathophysiology in narcolepsy is still been deciphered. Previous studies found that narcolepsy with cataplexy (N-C) is caused by early loss of hypothalamus neurons production hypocretin. Autopsy material also shows destruction of the hypocretin neurons in the lateral hypothalamus. Until now, very few brain image studies of pediatric narcolepsy have been presented. We design a prospective case

control study to investigate the neurophysiological mechanisms of pediatric narcolepsy using PET.

Methods: We included forty 9-20 year old children with N-C based on ICSD-2 criteria. Ten age and gender matched healthy children form the normal control group. All subjects underwent systematic investigations including, (1) clinical interview based on ICSD-2 and Stanford narcolepsy questionnaire, (2) sleep-wake evaluation questionnaires, (3) psychotic symptoms evaluation based on DSM-IV, (4) sleep evaluation such as actigraphy, polysomnography (PSG) and MSLT, (5) blood tests, and (6) PET study at same daytime. Data were analyzed with SPSS, version 18. Variables are presented as either mean \pm standard deviation or frequency. The students' t-test was used to compare the demographic data and the lab data. PET data were analyzed using SPM8 software.

Results: The forty N-C patients were sub-divided into isolated N-C group (N = 29) and NC with secondary schizophrenia group (N = 11), and healthy control group (N = 10). The patient group includes 25 male (62.5%) with current mean age of 17.39 years, all are positive for DQB1 0602 and 13 with CSF analysis are with low hypocretin. PET results: There are significant differences between N-C and normal controls with presence of hypometabolism in frontal lobe, anterior cingulate, and overall cortex ($P < 0.05$). A hypometabolism trend is noted in the basal ganglia, thalamus and parietal lobes. There is no difference in hypometabolism in N-C and N-C with schizophrenia.

Conclusion: Pediatric narcoleptic-cataplectics present hypometabolic regions during awake daytime study.

0665

EFFICACY OF CURRENT NARCOLEPSY TREATMENTS: ARE WE SETTING THE BAR TOO LOW?

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Introduction: The U.S. Food and Drug Administration (FDA) held a public meeting on narcolepsy in the fall of 2013 to gather information directly from patients about issues pertaining to disease burden and drug development. In preparation, Wake Up Narcolepsy, Inc. developed a patient advocacy initiative called Unite Narcolepsy to survey patients on questions posed by the FDA. We report these responses in an effort to inform sleep clinicians and researchers about common concerns, perceptions, and efficacy of treatment options reported by patients with narcolepsy.

Methods: A cross-sectional, 25-item survey was posted on the website of Unite Narcolepsy from 8/26/2013-11/15/2013. Data collection was anonymous and through an online survey instrument. Data analysis was performed at Boston Children's Hospital with Institutional Review Board approval. In total, 2017 patients completed the survey. We report data from 1697 respondents with narcolepsy and their direct care providers.

Results: Most patients (61.8%) completing the survey were between the ages of 25-54 years, and 58.6% have cataplexy. 78.2% reported having narcolepsy symptoms for more than three years. Patients reported that excessive daytime sleepiness (EDS; 64.8%), constant fatigue (37.4%), and difficulty with cognitive demands (40.8%) were the top three symptoms that impacted their lives. 85.4% (939/1100) of patients reported improved EDS with FDA-approved prescription drugs. However, on these treatments, only 42.3% (293/692) of respondents experienced improved cognition, and 51.8% (329/635) reported improved fatigue.

Conclusion: Many patients benefit from FDA-approved medications for narcolepsy, but most still struggle with daily symptoms. Feelings of fatigue often persist despite improved EDS, suggesting that fatigue may have a separate cause. Cognitive issues such as poor concentra-

tion, inattention, poor memory, and disorganization are very common and are often unappreciated by clinicians. These symptoms go beyond EDS, and hopefully future drug development efforts can target these important symptoms.

Support (If Any): Wake Up Narcolepsy, Inc.

0666

A 12-WEEK OPEN-LABEL, MULTICENTER STUDY EVALUATING THE SAFETY OF SODIUM OXYBATE (SXB) IN PATIENTS WITH NARCOLEPSY

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Introduction: SXB is approved for the treatment of cataplexy and excessive daytime sleepiness (EDS) in narcolepsy. This 12-week, open-label study evaluated the safety of SXB in patients who were SXB-naïve or had participated in SXB trials without achieving clinical effect.

Methods: SXB was initiated in all patients at 4.5 g/night and titrated in 1.5 g increments to 6, 7.5, or 9 g/night or down to 3 g/night. Dose adjustments and safety assessments occurred every 2 weeks. Patients were allowed to continue stable doses of stimulants for EDS and of antidepressants for cataplexy. Safety was the primary outcome. Efficacy was evaluated using the Narcolepsy Symptom Assessment Questionnaire (NSAQ), which assessed changes in specific symptoms and rated their overall condition on a 5-point scale ranging from “much worse” to “much improved.” Responders were defined as those feeling “much improved” or “somewhat improved” at Week 12.

Results: 171 (85%) of the 202 patients completed treatment. Mean age was similar across doses (41.9 ± 14.9 years), but anthropometric data were significantly different (both $P < 0.05$); heavier patients were generally titrated to higher doses. Treatment discontinuation reasons included: adverse events (AEs; 4%), patient noncompliance (3%), lost to follow-up (1%), protocol departure (1%), and other (4%). AEs were reported in 114 patients (56%). Serious AEs occurred in 5 patients (2%), 2 were treatment-related, headache and psychosis, the latter resulted in discontinuation. The most common AEs were nausea (10%), headache (7%), and dizziness (5%). 87% of patients received sympathomimetic stimulants during the study. Final doses were 3 g ($n = 5$), 4.5 g ($n = 29$), 6 g ($n = 80$), 7.5 g ($n = 66$), and 9 g ($n = 22$). Overall, 90% of patients were responders; 60% rated their overall narcolepsy symptoms as “much improved,” which appeared to be dose-dependent.

Conclusion: In this 12-week open-label trial, the safety profile was consistent with the parent clinical trials. Most patients were responders based on the NSAQ.

Support (If Any): This study was funded by Jazz Pharmaceuticals.

0667

TIME TO RESPONSE WITH SODIUM OXYBATE FOR THE TREATMENT OF EXCESSIVE DAYTIME SLEEPINESS (EDS) AND CATAPLEXY IN PATIENTS WITH NARCOLEPSY

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Introduction: Sodium oxybate (SXB) is approved for the treatment of excessive daytime sleepiness (EDS) and cataplexy in narcolepsy. This post hoc analysis evaluated the time to response.

Methods: Data were from a randomized, placebo-controlled, parallel-group trial (GHB-2; $N = 136$), which evaluated 4-week double-blind treatment with oral SXB 3 g, 6 g, and 9 g nightly, and its active drug open-label extension (GHB-3) for 12 additional months. Two responder definitions were developed based on analysis of the relationship of Clinical Global Impression of Change with Epworth Sleepiness Score (ESS) and number of cataplexy attacks: improvement in EDS as determined by $> 20\%$ decrease in ESS, and $\geq 50\%$ reduction in cataplexy attacks. Kaplan-Meier curves and median times to first response and maximum response were estimated over the GHB-2 and GHB-3 time periods.

Results: Among patients initially randomized to SXB in GHB-2, the median (95% CI) times to first response were 37 (31-50) days for ESS and 25 (17-29) days for cataplexy; 77.6% (66 of 85) and 90.7% (78 of 86) of patients responded based on ESS and cataplexy definitions, respectively. Median times to maximum response were 106 (85-164) days for ESS and 213 (94-279) days for cataplexy. Results in GHB-3 among 29 patients initially randomized to placebo were generally consistent with those treated with SXB throughout, but with a longer time to achieve maximum response.

Conclusion: Onset of therapeutic response, assessed as clinically meaningful improvements in EDS and cataplexy, was observed in $\geq 50\%$ of patients within 2 months. Importantly, a longer period is needed to achieve maximum response in most patients, and clinicians should recognize that the time course to initial and maximum response may take weeks to months.

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0668

INTRAVENOUS IMUNOGLOBULINS: A TREATMENT FOR NARCOLEPSY-CATAPLEXY IN PEDIATRICS?

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Introduction: Narcolepsy is a neurological disorder caused by the brain's inability to regulate sleep-wake cycles normally. Its prevalence dramatically increased after AS03 adjuvanted pandemic A(H1N1) vaccination campaign during winter 2009-2010, suggesting an immune origin. In this context, intravenous immunoglobulins (IVIg) have been used. The aim of this study is to evaluate the efficiency and the tolerability of this treatment in pediatric patients.

Methods: A literature review was performed in December 2012. Then, we conducted a retrospective study between January 2010 and December 2012 to evaluate the efficiency of IVIg in this disease. We collected data in medical files after identifying narcoleptic patients who received IVIg. Follow-up period started one month before the first IVIg administration and ended one month after the last one. Efficiency criteria used

were the evolution of pediatric narcolepsy scale scores (Pediatric Day-time Sleepiness Scale [PDSS], and cataplexy scale [CGI-C]) and the sleep latency increase (Multiple Sleep Latency Test [MSLT]). Statistic test used was students' t-test with paired samples.

Results: Only one double-blind placebo-controlled study ($n = 1$) was found and didn't show a significant difference between placebo and IVIg. No clinical trial was reported in clinicaltrial.gov. In our hospital, 23 pediatric narcoleptic patients received IVIg (1 gram/kg) on a 4-week interval basis between January 2010 and December 2012 (mean age: 12.2 years old). 69.6% received the AS03 adjuvanted pandemic A(H1N1) vaccine. Some patients also received concomitant psychostimulant-based treatment. For patients without change in psychostimulant-based treatment during the follow-up period (39.4%), the study showed a statistically significant decrease in cataplexy frequency ($n = 16$, $p = 0.04$), in excessive daytime sleepiness ($n = 7$, $p = 0.027$) and a statistically significant increase in sleep latency ($n = 5$, $p = 0.027$).

Conclusion: These findings are encouraging but need further analysis. We are currently working on a controlled-case study to verify these findings.

0669

THE UTILITY OF THE SUSTAINED SLEEP LATENCY ON POLYSOMNOGRAPHY (PSG) AND THE MULTIPLE SLEEP LATENCY TEST (MSLT) IN THE DIAGNOSIS OF PATIENTS WITH HYPERSOMNOLENCE OF CENTRAL ORIGIN

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Introduction: The MSLT is routinely used to evaluate hypersomnolence, looking for pathologic sleepiness (defined as a mean sleep latency ≤ 8 minutes) and sleep-onset REM periods (SOREMs). The distinction between the central hypersomnias, namely narcolepsy with cataplexy (NC), narcolepsy without cataplexy (NwC) and idiopathic hypersomnia (IH), is often not straightforward in the absence of 2 SOREMs. Our objective is to explore the value of alternative sleep-onset criteria, the sustained sleep latency (SSL) in distinguishing among these groups.

Methods: We retrospectively gathered data from the MSLT and the previous night's PSG among 77 patients with known central hypersomnolence. We compared sleep latency (SL or the time elapsed from lights out to the occurrence of a single epoch of > 15 sec of sleep) and SSL (time to the onset of three consecutive epochs each of > 15 sec of sleep) in both studies as different measures of objective pathologic sleepiness (MSSL = mean sustained sleep latency, MSL = mean sleep latency, PSSSL = PSG sustained sleep latency, PSL = PSG sleep latency).

Results: Among the participants (NC = 18, NwC = 31, IH = 28), a significant positive correlation was seen between the MSSL and MSL as well as the PSSSL and PSL ($p < 0.001$). There was no significant relationship between the MSSL and PSSSL ($p = 0.054$) while the MSL and PSL showed a positive correlation ($p = 0.025$). Among groups, a significant difference was found for the MSSL and MSL ($p < 0.001$ and 0.002 , respectively). No difference was found for the PSSSL and PSL. Post-hoc analysis showed that MSSL was significantly higher in the IH group (5.9 ± 2.5) as compared to NC (2.9 ± 2) and NwC (4.2 ± 2.9). A similar trend was seen in the MSL but this did not reach significance.

Conclusion: The SSL as an alternative measure of pathologic sleepiness may be useful in differentiating among the hypersomnias of central origin in the MSLT, but not in the PSG.

0670

MSLT: EXAMINING THE DIAGNOSTIC UTILITY OF A 4 NAP VERSUS 5 NAP PROTOCOL

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Introduction: The 5-nap MSLT is undertaken to diagnose narcolepsy. The utility of the four nap vs. five nap MSLT has however not been evaluated. Our objective was to determine the likelihood of capturing a second SOREMP on the fifth nap when only one SOREMP was present on the initial four.

Methods: A retrospective chart review of MSLTs was performed between 2009-2012. Results of polysomnography (PSG), MSLT and individual characteristics were compared in those with a 4 vs. 5 nap protocol. T-tests and Chi square test were applied.

Results: Of the 444 patients who underwent MSLT over the 42 month period, 95 were excluded (stimulant usage within 2 weeks, no prior PSG available, or < 360 minutes of sleep on the PSG). Of the remaining 349, 265 (76%) underwent a 4 nap protocol and 84 (24%) received the 5 nap study. Mean age in the 4-nap group was 33.1 years (SD 16.6) vs. 33.5 (SD 15) in the 5-nap group. Gender, medical comorbidities and historical features like cataplexy, hallucinations or sleep paralysis were similar in both groups. On comparing data from the initial four naps in each group, the diagnosis of narcolepsy was made in 16% of cases in the 4 nap group versus 20% of cases in the 5 nap group ($p = 0.396$). Of 84 subjects on the 5 nap protocol, in only 3 cases (4%, all adults) did the fifth nap enable a diagnosis of narcolepsy. In adults, the fifth nap increased the mean sleep latency (MSL) by 50.8 seconds ($p < .001$).

Conclusion: The diagnostic yield of the five nap- MSLT appears similar to that of a four nap protocol and increases the MSL slightly. Thus we would suggest that a fifth nap may not be necessary in most clinical situations. This may reduce utilization of scarce sleep center resources.

0671

"WAKING UP IS THE HARDEST THING I DO ALL DAY": CAPTURING SLEEP DRUNKENNESS WITH THE PSYCHOMOTOR VIGILANCE TASK (PVT) DURING THE MULTIPLE SLEEP LATENCY TEST (MSLT)

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Introduction: Hypersomnia patients may report severe difficulty with awakening, requiring multiple alarms and experiencing prolonged periods of sleepiness or disorientation after sleep. This sleep drunkenness can be treatment-refractory and may prevent patients from taking naps that might otherwise be therapeutic. We sought to evaluate this phenomenon with PVT.

Methods: Hypersomnia patients performed a PVT immediately before and after MSLT nap opportunities 2 and 4. PVT measures were mean reciprocal of reaction time (RRT) and number of lapses (i.e., reaction time > 500 msec). Difference scores for RRT and lapses (pre-nap minus post-nap) were calculated.

Results: Forty-one patients (32 women, age 35.2 ± 13.2) participated. Average Epworth was 16.3 ± 4.8 . Mean sleep latency was 7.2 ± 4.9 min. Thirteen patients had 2+ SOREMS. RRTs before naps were slow (3.31 ± 0.72 for nap 2 and 3.42 ± 0.82 for nap 4) and worsened significantly after napping (3.04 ± 0.88 , $p = 0.001$, and 3.19 ± 0.94 , $p = 0.003$, with naps 2 and 4, respectively). Pre-nap lapses were frequent (8.9 ± 13.0 and 9.1 ± 15.9) and worsened with napping (12.3 ± 14.9 , $p = 0.06$ and 12.4 ± 17.7 , $p = 0.04$). Pre-nap performance was highly correlated between the two naps (Spearman rho = 0.84 for RRT and rho = 0.90 for lapses,

$p < 0.0001$ for both comparisons). Difference scores were moderately correlated between the naps ($\rho = 0.55$, $p = 0.0002$ for RRT, and $\rho = 0.44$, $p = 0.004$ for lapses). Poorer pre-nap PVT performance was moderately correlated with higher Epworth scores and lower mean sleep latencies (MSL). Difference scores did not correlate with Epworth, MSL, or other features.

Conclusion: Brief naps worsen vigilance in hypersomnia patients. Both pre-sleep vigilance and nap-induced vigilance deterioration are consistent in individuals across two administrations. While pre-sleep vigilance correlates with subjective and objective sleepiness, worsening vigilance with napping appears unrelated to conventional measures of sleepiness. Validated clinical instruments specific to the phenomenon of sleep drunkenness are needed.

0672

HABITUAL SLEEP DURATION, UNMET SLEEP DURATION, AND EXCESSIVE DAYTIME SLEEPINESS IN KOREAN ADULTS

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Introduction: Sleep need may be different from person to person, so sleep insufficiency may differ in each person even if ones get the same sleep duration. Thus, the aim of this study was to examine the separate and combined association of both habitual sleep duration and unmet sleep duration to excessive daytime sleepiness (EDS) in Korean adults.

Methods: The subjects included 2,769 Korean adults aged 19 years and older in a multi-stage clustered sampling from 15 administrative districts. They completed questionnaires about sleep habit over the previous 1 month. Information included age, sex, body mass index, snoring, smoking, alcohol drinking, physical activity, educational level, and job class. The question regarding sleep need was “how many hours do you think is enough?” Habitual sleep duration was defined by [(weekday sleep duration \times 5 days) + (weekend sleep duration \times 2 days)] / 7 days. Unmet sleep duration was calculated as sleep need minus habitual sleep duration. The participants with an Epworth Sleepiness Scale > 10 were considered as having EDS.

Results: The prevalence of EDS was 330 (11.9%). 31.9% reported not getting at least 7-8 hours of habitual sleep. Unmet sleep duration above 0 was evident in 30.2%. In adjusted multivariate logistic regression analysis, unmet sleep duration was related with EDS [(0 to < 2 hours, OR = 1.75; 95% CI: 1.75-2.41), (≥ 2 hours, OR = 2.29; 95% CI: 2.29 (1.64-3.20)]. However, short habitual sleep duration (versus 7 to < 8 hours) was not statistically significant [(< 6 hours, OR = 0.97; 95% CI: 0.64-1.48), (6 to < 7 hours, OR = 1.06; 95% CI: 0.77-1.46)].

Conclusion: EDS is associated with unmet sleep duration not habitual sleep duration when evaluated both variables together. We suggest individual unmet sleep duration is more important in terms of EDS.

0673

N-METHYL-D-ASPARTATE RECEPTOR ANTIBODY POSITIVE CASE WITH KLEIN-LEVIN SYNDROME

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Introduction: We have reported that the patients with orexin (hypocretin) deficient narcolepsy and severe psychosis had NMDA receptor (NMDAR) antibodies (APSS 2009, 2011). NMDAR antibody is produced against tumor and migrated to brain, and then present psychiatric symptoms. This paraneoplastic brain syndrome usually develops in young women with ovarian teratoma, but some cases are in elder men. Dr. Dalmau (2011), a pioneer of anti-NMDAR encephalitis, had mentioned that the patients' symptoms might resemble those of patients with Kleine-Levin syndrome (KLS; hypersomnia, compulsive hyperphagia, hypersexuality, apathy, child-like behaviour) in the recovery stage of the NMDAR encephalitis. In addition, the cause of Klein-Levin syndrome has not been solved yet. In this study, we measured NMDAR antibody in patients with KLS.

Methods: The study was performed 7 cases with KLS. Testing for NMDAR antibodies in CSF was performed in Kanazawa Medical University as following the method of Dr. Dalmau. The CSF orexin (hypocretin) levels were also measured. The patients were 6 males and one females, the age range was between 12 years to 26 years old (12/m, 12/m, 13/m, 14/f, 14/m, 15/m, 26/m).

Results: We found that one KLS patient was positive for the antibody (12/m) and others were negative. About the orexin levels, 6 cases were normal (> 200 pg/ml), one case (14/m) was intermediate level (118 pg/ml).

Conclusion: Two previous studies reported that some patients with contemporary Encephalitis Lethargia (EL) were positive for NMDAR antibodies (Dale 2009). Ten out of twenty patients were positive and these patients predominantly fit into the dyskinetic form of EL. The five patients with the somnolent-Parkinsonian form of EL, which is considered to be the classic form of EL were negative for NMDAR antibodies. These results together with the fact that 3 out of 5 narcoleptic subjects who were positive for anti-NMDAR antibodies exhibited severe psychiatric symptoms show that NMDAR antibody positivity may be more specifically related with occurrences of psychiatric symptoms. Further studies are needed to the NMDAR antibodies in the cases with KLS.

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0674

COMORBIDITY AND HEALTHCARE UTILIZATION IN NARCOLEPSY: AGE-RELATED FINDINGS FROM THE BURDEN OF NARCOLEPSY DISEASE (BOND) DATABASE

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Introduction: Comorbidity associations and concomitant healthcare cost burdens have been reported for narcolepsy; however, no large data-

bases have been analyzed investigating potential age-related patterns of narcolepsy burden of illness.

Methods: Five years of medical claims data were accessed using Truven Health Analytics MarketScan® Databases (> 50 million insured persons). Eligible subjects included adults who were continuously insured between 2006 and 2010 and had at least one narcolepsy diagnosis code. Non-narcolepsy controls were matched 5:1 on multiple factors. Extensive subgroup analyses were used to validate the population.

Results: The analysis population included 55,871 subjects (9,312 with narcolepsy; 46,559 matched controls; mean age 46.1 y; range, 18-93 y). Age categories (% of population) included: 18-24 y (3.8%), 25-34 y (16.8%), 35-44 y (24.7%), 45-54 y (30.4%), 55-74 y (21.1%), and 75+ y (3.2%). Among comorbidities previously associated with narcolepsy, the largest excess prevalence (narcolepsy over control) was found in persons aged 45-53 y for most conditions, although the youngest cohort (18-24 y) evidenced the greatest excess for anxiety/mood disorders. The % excess chronic illness burden (narcolepsy vs controls) was greatest in the 18-24 y (111%), 25-34 y (94%) and 35-44 y (85%) subgroups; the smallest % excess was observed in the 75+ y subgroup (32%). Among narcolepsy subjects, diagnoses of anxiety and mood disorders declined with increasing age. For all age subgroups, mean annual utilization rates for healthcare services and non-narcolepsy drugs were approximately doubled compared to controls, with the greatest excess noted among younger narcolepsy patients vs controls.

Conclusion: Narcolepsy is associated with a striking degree of medical comorbidity and substantial level of healthcare burden that is evident across all adult age categories. The relative burden of disease for narcolepsy subjects relative to their matched controls was highest in younger adult patients compared with older age categories.

0675

HEALTH CARE DISPARITIES IN THE DIAGNOSIS AND TREATMENT OF SLEEP DISORDERED BREATHING IN PATIENTS WITH SPINAL CORD INJURYSankari A¹, Bascom AT², Martin JL³, Badr MS¹¹Medicine, John D. Dingell VA Medical Center, Detroit, MI, USA,²Wayne State University, Detroit, MI, USA, ³VA Greater Los Angeles Healthcare System, North Hills, CA, USA

Introduction: Spinal cord injury (SCI) is associated with 2-5 times greater prevalence of sleep disordered breathing (SDB) than the general population. The objectives of this study were (1) to characterize sleep disturbances in patients with SCI using quantitative/qualitative questionnaires and (2) to determine the presence of SDB and rate of acceptance of positive airway pressure (PAP) therapy.

Methods: Twenty Six consecutive SCI patients [8 females; age 42.5 ± 15.5 years; BMI 25.9 ± 4.9 kg/m²; 15 cervical and 11 thoracic levels] completed a battery of questionnaires [Epworth Sleepiness Scale (ESS), Pittsburgh Sleep Quality Index (PSQI), Berlin questionnaire (BQ) and fatigue severity scale (FSS)], had a brief history and exam, and one night of attended polysomnography (PSG) with flow and pharyngeal pressure measurements. Studies were scored using American Academy of Sleep Medicine (AASM) criteria. Participants were then interviewed to assess acceptance of PAP therapy.

Results: Mean PSQI = 10.3 ± 3.7 , and 92% had PSQI > 5. Mean ESS = 10.4 ± 4.4 and 59% had ESS > 9. Mean FSS = 4.6 ± 1.6 with 96% having FSS > 2.0. 48% scored as high-risk for SDB on the BQ. Based on PSG, 20 (77%) patients had SDB (AHI > 5 events/hour; mean AHI = 29.3 ± 25.0). On follow-up interview, 16 (80%) patients with SDB were not treated despite having a positive PSG and follow-up instructions.

Conclusion: The majority of SCI patients have symptomatic SDB and poor sleep quality that may be missed if not carefully assessed. Many SCI patients remained untreated despite diagnosis of SDB and referral for treatment. Understanding the barriers and facilitators of diagnosis and treatment of SDB among SCI patients would improve the likelihood that patients receive high-quality care for SDB.

Support (If Any): The study was funded by the Department of Veterans Affairs (Career Development Award I01BX007080).

0676

PIB PET AMYLOID IS ASSOCIATED WITH SELF-REPORTED SLEEP IN COGNITIVELY HEALTHY LATE MIDDLE-AGED ADULTS.Sprecher KE^{1,2,3}, Bendlin BB^{6,7,3}, Okonkwo OC^{5,6,3}, Christian BT^{5,7,3}, Sager MA^{5,8,3}, Johnson SC^{5,6,8,3}, Benca RM^{2,3}¹Neuroscience Training Program, Madison, WI, USA, ²Wisconsin Center for Sleep Medicine and Research, Madison, WI, USA,³Department of Psychiatry, University of Wisconsin, Madison, WI, USA, ⁴Alzheimer's Disease Research Center, Madison, WI, USA,⁵Geriatric Research Education and Clinical Center, Madison, WI, USA,⁶Department of Medical Physics, University of Wisconsin, Madison, WI, USA, ⁷Wisconsin Alzheimer's Institute, Madison, WI, USA

Introduction: Formation of amyloid plaques in the brain is thought to be one of the earliest processes in the pathogenesis of Alzheimer's disease (AD). Cognitively healthy older adults with greater amyloid burden report shorter and lower quality sleep, and sleep disruption in rodents increases amyloid production and deposition. We examined the relationship between regional amyloid burden and self-reported sleep in late middle-aged adults. We hypothesized that poorer sleep would predict greater amyloid deposition in AD-sensitive brain regions.

Methods: We studied 59 cognitively healthy adults (mean age 61.4 years, SD 5.62) from the Wisconsin Registry for Alzheimer's Preven-

tion who had completed sleep questionnaires and Positron Emission Tomography (PET) using [C-11]Pittsburgh Compound B (PiB). Multiple regression was used to test the extent to which scores on the Epworth Sleepiness Scale (ESS) and the Medical Outcomes Study (MOS) Sleep Scale predict PiB distribution volume ratios in brain regions that are heavily affected by amyloid pathology in AD, including the precuneus (PQ and subparietal sulcus (SPS). Analyses controlled for age, gender, body mass index, APOE4 genotype and parental history of AD.

Results: Participants reporting greater sleepiness on the MOS showed greater amyloid burden in PQ and SPS (PQ: beta = .319, p = .012; SPS: beta = .278, p = .028). Higher amyloid in these regions was also associated with less adequate sleep (PQ: beta = -.395, p = .001; SPS: -.368, p = .003), more daytime napping (SPS: beta = -.281, p = .028) and a higher sleep problems index (PQ: beta = .39, p = .001, SPS: beta = -.368, p = .01) on the MOS. There was no association between amyloid and snoring, awaking short of breath, sleep disturbance, trouble falling asleep, sleep amount or ESS score.

Conclusion: Sleep disruption in cognitively healthy adults was associated with greater amyloid burden in AD-sensitive brain regions, providing a potentially modifiable risk factor for AD. The discrepancy between MOS and ESS sleepiness ratings underscores the need for further studies incorporating objective sleep measures.

Support (If Any): This research was supported by National Research Service Award (NRSA) T32 GM007507, CTSA award UL1TR000427 and by the National Institute on Aging (R01 AG027161, ADRC P50 AG033514, R01 AG021155, and R01 AG037639).

0677

BLOOD PRESSURE AND HEART RATE REGULATION IS ALREADY DISTURBED IN "IDIOPATHIC" REM SLEEP BEHAVIOUR DISORDER DUE TO PERIPHERAL AUTONOMIC DENERVATION

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Introduction: Impaired blood pressure (BP) and heart rate (HR) regulation is a prominent feature in α -synucleinopathies. The arterial baroreflex is the major determinant in cardiovascular regulation. Baroreflex regulating cerebral areas are early involved in synuclein-mediated neurodegeneration. However, it is unclear, whether BP/HR regulation is already disturbed in prodromal α -synucleinopathies such as REM sleep behaviour disorder (RBD). We hypothesized that BP/HR dysregulation is present and mediated by baroreflex dysfunction in RBD.

Methods: We determined BP/HR response to orthostatic challenge, HR variability (HRV) and BP variability (BPV) in the frequency domain [HRV: high frequency (HF), low frequency (LF), very low frequency (VLF) band power; BPV: HF, LF band power] to assess cardiac/vascular autonomic innervation and baroreflex sensitivity (BRS) in 20 patients with "idiopathic" RBD (i.e., without further neurodegenerative symptoms) and 20 healthy controls.

Results: Resting BP/HR did not differ between RBD and controls. During the orthostatic challenge, increase in systolic ($p \leq 0.04$) and diastolic BP ($p \leq 0.04$) was diminished in RBD patients but HR response was unchanged compared to controls. HRV band power was lower in all spectral bands (total $p \leq 0.02$, HF $p \leq 0.05$, LF $p \leq 0.04$, VLF $p \leq 0.007$) in RBD compared to controls, indicating cardiac autonomic denervation. BPV LF ($p \leq 0.01$) but not HF band power was also diminished in RBD patients, indicating peripheral vascular autonomic denervation. BRS did not differ between RBD patients and controls.

Conclusion: Autonomic dysregulation is already present but—in contrast to our hypothesis—baroreflex function is preserved in prodromal α -synucleinopathy. Diminished orthostatic BP/HF response must arise

from peripheral autonomic cardiac/vascular denervation as indicated by lower HRV and BPV in RBD patients.

0678

CYCLIC ALTERNATING PATTERN (CAP) NREM SLEEP MICROARCHITECTURE IN PATIENTS WITH CLINICALLY DIAGNOSED DEMENTIA WITH LEWY BODIES AND ALZHEIMER DISEASE

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Introduction: Cortical brain arousal may be indexed by NREM cyclic alternating pattern (CAP) sleep, which is thought to reflect cerebral cortical infraslow oscillatory activity. Both CAP microarchitecture and slow cortical oscillations have been shown to correlate with cognition. We aimed to determine whether CAP sleep rates differed between two subgroups of patients with clinically diagnosed neurodegenerative disorders: Dementia with Lewy bodies (DLB) and Alzheimer disease (AD). **Methods:** Full night diagnostic polysomnographic data of 32 (20 DLB and 12 AD) patients were manually analyzed using Hypnolab CAP scoring software (ATES Medica Labs, Verona, Italy). CAP sleep rate and CAP subtype metrics during polysomnography were obtained. Cognitive status was assessed by total score and attention subscale of the Dementia Rating Scale-2 (DRS-2).

Results: Mean ages of the groups were AD 66.1 years and DLB 71.6 years (range 57-85 years, $p = 0.06$). There were 27 men and 5 women. Mean apnea/hypopnea index was < 10 /hour in both groups. Overall CAP rates were similar between groups (AD 35.4%, DLB 29.9%, $p = 0.80$). DRS-2 overall and attention subscale scores were similar between groups (overall $p = 0.82$, attention subscale $p = 0.40$). Higher attention subscale and overall DRS-2 scores were positively correlated with overall CAP rates and CAP A1 subtype (overall $p = 0.036$, attention subscale $p = 0.008$) in DLB patients only, whereas in AD patients, CAP metrics did not correlate with cognitive status.

Conclusion: Cognitive status and attention were positively correlated with overall and A1 CAP subtype metrics in DLB but not AD patients. These findings suggest that in DLB, sleep promoting CAP A1 subtype rhythms may be associated with better sleep consolidation that could improve daytime cognitive functioning and attention. Further analysis of larger numbers of DLB and AD patients may further clarify differences in cortical arousal potential between these patient groups, and enable correlation with clinical outcomes of cognitive performance.

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0679

THE EFFECT OF VALPROIC ACID ON THE SLEEP QUALITY OF JUVENILE MYOCLONIC EPILEPSY PATIENTS: A LONGITUDINAL SLEEP QUESTIONNAIRE-BASED STUDY

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Introduction: Excessive daytime sleepiness (EDS) and daytime fatigue are common in patients with epilepsy worldwide. The aim of this study was to analyse the influence of sodium valproic acid (SVA) on the sleep quality of patients with Juvenile Myoclonic Epilepsy (JME).

Methods: Assessment of the phenotype and sleep quality using standardized sleep questionnaires (Epworth Sleepiness Scale: ESS; Pittsburgh Sleep Quality Index: PSQI) in 30 patients with JME (M:F = 17:13; age: 24 ± 4 years) before and after starting SVA was performed. Various parameters noted in drug-naïve period and 9.32 ± 2.16 months after starting SVA, were analyzed using t-test and chi-squared contingency tables.

Results: The mean age at onset of seizures and diagnosis was 16.42 ± 6.7 years and 22.68 ± 9.32 years respectively. At diagnosis, all patients had myoclonic jerks with mean duration of 5.79 ± 4.41 years, aggravated by sleep deprivation in 23 (96.7%) and sleep-wake transition in 29 (76.7%). Twenty-seven (90%) had GTCS, majority (70%) on waking from sleep. With SVA, seizures were controlled in 25 (83.3%) patients. An abnormal ESS score ≥ 11 was noted in 5 (16.7%) drug naïve JME compared to 6 (20%) JME while on SVA ($p = 0.74$). The mean ESS among drug naïve JME was 6.33 ± 4.5 compared to 6.97 ± 4.9 among JME while on SVA ($p = 0.6$). An abnormal PSQI score ≥ 6 was observed in 14 (46.7%) drug naïve JME as compared to 4 (13.3%) patients after initiating SVA ($p = 0.005$). The mean PSQI among drug naïve patients was 6.63 ± 5.3 compared to 2.7 ± 2.9 after initiating SVA ($p = 0.0007$).

Conclusion: This study showed that the PSQI score improved and those with abnormal PSQI scores reduced after starting SVA and seizure control, suggesting improvement in their nighttime sleep quality. However, the ESS score didn't change with SVA in patients with JME. This suggests that patients with JME may show significant improvement in their night time sleep quality after initiation of SVA which could be attributed to seizure control.

Support (If Any): This study was supported by partial funding from the Department of Science and Technology, Government of India, New Delhi (SR/SO/HS/108/2007).

0680

CO-MORBID OBSTRUCTIVE SLEEP APNEA IN REFRACTORY MONITORED EPILEPSY INPATIENTS: FREQUENCY, CLINICAL PREDICTORS, AND RELATIONSHIP WITH INTERICTAL HEALTH-RELATED QUALITY OF LIFE DETERMINANTS

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Introduction: We aimed to determine the frequency of and clinical predictors for probable OSA in refractory monitored epilepsy inpatients, and to determine the association of probable OSA with interictal sleep disturbance, mood state, cognitive functioning, and antiepileptic drug (AED) adverse effects in monitored epilepsy inpatients.

Methods: Adult monitored inpatient subjects with refractory epilepsy (1 or more seizures per month) were recruited. Subjects then completed a

sleep apnea questionnaire (SA-SDQ), Epworth Sleepiness Scale (ESS), Pittsburgh Sleep Quality Index (PSQI), Adverse Events Profile (AEP), Zung Depression Scale (ZDS), CNS Vitals Signs Neurocognitive Index (NCI), Quality of Life in Epilepsy-31 (QOLIE-31), and overnight oximetry studies. Linear regression analyses were performed utilizing JMP.

Results: 46 subjects (25 (54%) women) with a mean age of 35.6 (range 20-65) participated. Thirty-three (71%) had focal epilepsy, 5 (12%) were unclassified, and 8 (17%) had primary generalized epilepsy syndromes, with mean duration of 16.3 years (range 1-47 years) and mean of 8.7 seizures/month (range 1-61, $sd = 14.9$). 18/46 (39%) had either abnormal oxyhemoglobin desaturation index ($ODI > 5/\text{hour}$) or SA-SDQ scores above cut-off signifying probable OSA. In multivariate analyses, BMI ($p < 0.02$) and age ($p < 0.0001$) were associated with probable OSA, while AED load ($p = 0.81$) and AEP scores ($p = 0.22$) were not. SA-SDQ scores were associated with AEP ($F = 14.3$ $p = 0.006$) and PSQI scores ($F = 6.65$, $p = 0.014$), but were unassociated with ZDS ($p = 0.40$) or CNSVS NCI ($p = 0.91$). ESS scores were associated with focal epilepsy diagnosis ($p = 0.008$) and seizure frequency ($p = 0.028$), and trended toward association with CNSVS NCI ($p = 0.055$). Lower QOLIE-31 scores were associated with higher AEP ($F = 12.5$, $p = 0.001$) and ZDS ($F = 12.0$, $p = 0.0009$) scores, but not seizure frequency ($p = 0.54$).

Conclusion: Probable co-morbid OSA was identified in 39% of monitored epilepsy inpatients, and was associated with higher levels of patient-reported antiepileptic drug adverse (AED) effects, which were in turn associated with lower quality of life. Sleepiness in epilepsy inpatients appeared more related to focal epilepsy type and frequent seizures than OSA symptoms. Screening for OSA and AED adverse effects that may impact health and health-related quality of life is an important consideration in monitored epilepsy inpatients.

Support (If Any): The project described was supported by the National Center for Research Resources and the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant Number 1 UL1 RR024150-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

0681

SLEEP DISTURBANCES IN PERSONS WITH EPILEPSY IN NIGERIA: A MULTICENTER STUDY

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Introduction: Persons with epilepsy (PWE) are at risk of developing sleep disorders and there is a complex inter-relationship between sleep disorders and epilepsy.

Methods: This was a multicenter cross-sectional study in Nigeria. Patients with cognitive defects, spontaneous sleep complaints and use of hypnotics were excluded from the study. The data was analyzed using SPSS 11.0.

Results: There were 150 PWE in the study comprising 94 males and 56 females with a mean age in years was 30.0 (SD14.0), range 16-70 years. The mean age of seizure onset was 26.0 (SD14.0). Majority had secondary generalized tonic-clonic seizures (56%). About 82% of PWE have sleep disorders and the commonest sleep disorder was parasomnia (47%) followed by insomnia (33%), obstructive sleep apnoea (23%), excessive daytime sleepiness (19%) and restless leg syndrome (11%). The type of accommodation that PWE lives in and the time of seizures respectively predicted the presence of excessive daytime sleepiness and parasomnia in the PWE ($P < 0.05$).

Conclusion: There is a high prevalence of sleep disorders among persons with epilepsy in Nigeria.

0682

COMPLIANCE WITH NASAL CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) IN EPILEPSY AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is prevalent in nearly a third of patients with epilepsy. Treatment with continuous positive airway pressure (CPAP) is associated with improvement in seizure control. However, CPAP is often difficult to tolerate for various reasons, and it has been suggested that noncompliant patients with epilepsy and OSA are at higher risk of recurrent seizures than are CPAP-compliant patients. Our objective is to determine short-term compliance, which predicts long-term adherence, to CPAP therapy in patients with OSA and epilepsy. Our preliminary data were presented earlier at the 2013 WASM Annual Meeting in Valencia, Spain.

Methods: We retrospectively identified patients with moderate to severe OSA ($AHI \geq 15$) started on nasal CPAP between 2012-2013 at the New York Sleep Institute. We divided them into OSA-only (control) and epilepsy-OSA groups. Patients with history of non-epileptic seizures, poor compliance with anti-epileptic drugs, greater than ten seizures a day, diagnosis of epilepsy within the past six months, a significant history of medical, psychiatric or substance abuse, or a two month compliance rate of less than ten percent were excluded. CPAP compliance (defined as percent of days with greater than 4 hours usage) was obtained via a monitoring card within the CPAP system.

Results: Seventy-five epilepsy patients were identified, forty-nine (65%) of which were diagnosed with concomitant OSA. Thirty-three patients from the control group and fourteen epilepsy patients met inclusion criteria. Mean age was 50.7 and 60.5 ($p = 0.016$), BMI was 32.3 and 32.2 ($p = 0.47$), Epworth Sleepiness Scale was 8.4 and 9.6 ($p = 0.27$), spontaneous arousal index 10.0 and 7.5 ($p = 0.16$), sleep efficiency was 80.7% and 79.2% ($p = 0.38$), optimal CPAP pressure was 11.4 and 10.6 cm H2O ($p = 0.21$), and AHI 30.2 and 40.2 ($p = 0.09$), in the epilepsy-OSA and OSA-only groups, respectively. One month compliance rates were 65.7% in epilepsy patients and 78.9% in the control group ($p = 0.029$), and two month compliance rates were 68.3% and 71.5%, respectively ($p = 0.33$).

Conclusion: Short-term compliance rates were decreased in epilepsy patients with concomitant OSA, most notably within the first month after beginning CPAP. This study demonstrates the importance of providing early and aggressive support, in this particularly vulnerable group.

Support (If Any): We thank the staff at New York Sleep Institute for their dedication and support.

0683

DIFFERENCES IN PERCENTAGE REM STAGE BETWEEN PATIENTS WITH LEFT AND RIGHT TEMPORAL LOBE EPILEPSY

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Introduction: Sleep disturbance is common in patients with epilepsy. The abnormal sleep architecture is characterized by frequent shifts in sleep stages with numerous awakenings and longer duration of light

sleep following sleep onset, especially in patients with temporal lobe epilepsy (TLE). However, the relationship between seizure lateralization and sleep macrostructure in patients with any type of epilepsy remains unclear. The present study compared sleep macrostructures in patients with left and right TLE.

Methods: This study included 17 patients with TLE, 7 men and 10 women aged 17 to 50 years, who underwent simultaneous polysomnography and long-term video EEG monitoring. Ten and seven patients were diagnosed with left and right TLE, respectively. Sleep stages were scored based on the American Academy of Sleep Medicine criteria. Total sleep time, sleep latency, REM latency, sleep efficiency, time and percentage of each sleep stage, and apnea-hypopnea index were compared between the patients with left and right TLE.

Results: Percentage REM stage was significantly ($p = 0.021$) lower in patients with left TLE ($10.1 \pm 5.9\%$) than in those with right TLE ($16.3 \pm 2.9\%$). Other parameters showed no significant difference between the two groups.

Conclusion: Epileptic dysfunction of the left temporal lobe was associated with inhibition of REM sleep. The present result contradicts a previous report that left hemispheric cerebral infarction was associated with augmentation of REM sleep. Left temporal lobe may be closely related with modulation of REM sleep.

0684

EPILEPSY IS NOT A RISK FACTOR FOR SLEEP- DISORDERED BREATHING IN NON-OBESE JAPANESE

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Introduction: Sleep-disordered breathing (SDB) has been estimated to occur in 24% of men and 9% of women. Obesity is the strongest risk factor for SDB. However, even non-obese Japanese people can be at risk for SDB because of craniofacial anatomical factors. Consequently, the prevalence of SDB in Japan is similar to that in the US. Epilepsy is also a well-known risk factor for SDB in the US, with the prevalence of 60% in men and 40% in women. However, this relationship has never been evaluated in Japan. This study investigated the prevalence of SDB in Japanese patients with epilepsy.

Methods: We retrospectively reviewed 85 consecutive patients with epilepsy, 41 men and 44 women aged 13 to 75 years, who underwent long-term video-EEG monitoring with overnight polygraphy. The polygraphs and apnea hypopnea indexes (AHIs) were analyzed. Nineteen patients were diagnosed with generalized epilepsy, 37 with temporal lobe epilepsy, 5 with extra-temporal lobe epilepsy, and 27 with non-localizable focal epilepsy. The patients were classified based on seizure frequency into the following 4 groups: 25 patients with daily seizures, 24 weekly, 32 monthly, and 17 yearly. All patients were treated with 2.4 ± 1.4 anti-epileptic agents (mean \pm SD). In addition, 15 patients took benzodiazepine, 5 antidepressant, and 2 antipsychotic drugs.

Results: Fifteen of 41 men with epilepsy showed AHI > 5 . No significant correlation was seen between AHI and localization of epileptic focus, seizure frequency, or number of antiepileptic drugs. None of 44 women had AHI > 5 .

Conclusion: The prevalence of SDB in patients with epilepsy was lower in Japan than in the US, but is similar in Japan and the US in the general population. Epilepsy is one of the risk factors for SDB in Caucasians, but not in non-obese Japanese.

0685

COMPARISON OF POLYSOMNOGRAPHIC (PSG) AGAINST POST-PSG AND SLEEP-LOG SELF-REPORTED SLEEP MEASURES IN ADULTS WITH EPILEPSY

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Introduction: There's a paucity of research exploring sleep-log validity in epilepsy. Self-report sleep measures may be cost-effective in epilepsy-related sleep research.

Methods: Mean 1-week sleep-logged total sleep time (MLTST) and sleep latency (MLSL), overnight PSG total sleep time (PSGTST) and sleep latency (PSGSL), and post-PSG self-report total sleep time (SRTST) and sleep latency (SRSL) were analyzed in adults with epilepsy. Comparisons to usual nights were reported on a 1-5 scale, with a score of 3 being "usual". First night effect (FNE) was defined as SRTST compared to usual. Mean monthly seizure frequency (MMSF) was modeled binomially, defined with cut-point of 4/month. Pearson correlations were used for normally distributed variables, Spearman's for skewed, Fisher's exact test for 4-way table comparisons, and linear regressions for modeling.

Results: 48 patients (aged 41 ± 13 , 36 (75% female)) were included, with MMSF of 2.9 ± 6.6 (right-skewed; 39.6% had > 1 seizure/month). Mean PSGTST was 369.6 min (6.2 hr), MLTST 7.8 hr and SRTST 6.0 hr, and SRSL 34.0 min. SRTST versus usual comprised: 46.8% same time, 13.5% longer, 33% shorter, with SRSL versus usual comprising: same 41.6%, 12% shorter, 43% longer. SRTST Pearson-correlated ($r = 0.452$, $p = 0.0016$) with PSGTST. PSGSL versus SRSL Spearman-correlation ($r = 0.5$) was significant ($p < 0.0004$), likewise Fisher-testing ($p = 0.00043$) using 30-minute cut-points. MLTST was non-significantly, but positively related to PSGTST after correction for FNE (model-omnibus $p = 0.07$); even with larger-model corrections for SRSL nor MMSF. MMSF and anti-convulsant number as predictors of PSGTST proved non-predictive after age (-3.5 min/year, $p = 0.0004$) correction.

Conclusion: Adults with epilepsy adequately estimated prior-night PSGTST and PSGSL greater than 30 minutes, but sleep-logged TST poorly predicted PSGTST, even with correction for FNE. Age greatly predicted PSGTST. Self-reported sleep measures may be valid in epilepsy patients, but research methods for using sleep logs and doing age-corrections remain underdeveloped in relation to hypotheses about seizure frequency and effect of anticonvulsants affecting sleep.

0686

VAGAL NERVE STIMULATOR INDUCED 'PEARLS ON STRING' CHIN EMG ARTIFACT

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Introduction: Vagal nerve stimulator (VNS) has been approved for the treatment of refractory partial seizures and has been in use for more than a decade. Effects of VNS on sleep architecture and sleep disordered breathing are known. It can also affect polysomnographic sleep recording.

Methods: Two cases of VNS induced chin EMG artifact were described along with the review of literature on VNS effects on sleep.

Results: Vagal nerve stimulator has been approved for the adjunctive treatment of refractory partial seizures and recently for the treatment of refractory depression. It has been known to us for many years that VNS can impact sleep. It is known to be associated with obstructive apneas, central apneas, oxygen desaturation and hypercapnia. We present two cases with a fairly specific chin EMG artifact noted at the time of VNS firing. The artifact can be described as 'pearls on string' based on its morphology. This artifact precedes the appearance of the respiratory

event. Recognition of this artifact can help clinicians in understanding the nature of the accompanying respiratory event and the VNS contribution to it. It also helps in identifying the patients with VNS while reading polysomnograms where the history of such may not be provided at the time of reading the study.

Conclusion: We describe a polysomnographic feature seen in patients on VNS. Recognition of VNS induced chin EMG artifact is important for the polysomnographer and may help with the understanding of the nature of sleep related respiratory events.

0687

HYPERKALEMIC PERIODIC PARALYSIS MASQUERADING AS SLEEP ONSET PARALYSIS

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Introduction: Hyperkalemic periodic paralysis (HPP) is an autosomal dominant muscle sodium channelopathy characterized by flaccid muscle weakness or paralysis. Attacks can be precipitated or made worse by cold, rest after exercise, anesthesia, potassium loading, hunger, emotional stress, pregnancy and glucocorticoids. Sleep has not been well described as one of the triggers for paralysis. HPP can be confused with sleep paralysis and in some cases with cataplexy. Many patients go undiagnosed for decades. Neurology and sleep literature is lacking in sleep associated periodic paralysis.

Methods: 61 year old woman with life long sleep onset associated paralysis which has resulted in chronic insomnia and fear of falling asleep. Paralysis can also be precipitated by eating salted peanuts.

Results: She comes from a large family where many members suffer from the same condition (maternal grandmother, mother, sister, brother, and daughter) and only one of her brothers has been formally diagnosed. She was referred to sleep medicine clinic to evaluate for "narcolepsy variant" and was diagnosed there with HPP.

Conclusion: HPP has varied presentations and should be considered in patients with sleep onset paralysis thus preventing prolonged time to appropriate diagnosis and treatment which can last for decades.

0688

PREVALENCE AND SEVERITY OF SLEEP DISORDERED BREATHING (SDB) IN AMYOTROPHIC LATERAL SCLEROSIS (ALS) PATIENTS

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Introduction: ALS is a neurodegenerative disorder characterized by loss of both upper and lower motor neurons. We investigated the prevalence and severity of SDB among ALS patients in a single center population.

Methods: We retrospectively analyzed the data of 71 consecutive ALS patients at the James Haley Veterans Hospital from 1/1/2010 to 12/5/2013. Patients' demographics, chronic diseases, forced vital capacity (FVC), and polysomnography or type 3 portable monitoring (PM) data were recorded.

Results: 71 patients [Males: 70, Females: 1] with definite ALS according to the standard criteria were evaluated. Mean \pm standard deviation for patients Age was (64.37 \pm 10.99) years. Body mass index was (26.14 \pm 4.48) kg/m² and FVC was 2.89 \pm 1.04 liters, (62.50 \pm 21.71% predicted) respectively. Significant SDB defined as a Respiratory Disturbance Index (RDI) or Apnea Hypopnea Index (AHI) of 5 or greater was found in 57.75% (41/71) of our population whereas an AHI or RDI of 15 or greater was found in 38.03% (27/71) of our patients. In other words:

65.85% (27/41) of those with OSA were classified as moderate to severe. The mean for RDI or AHI was (23.30 \pm 17.17) and Desaturation index was (16.39 \pm 15.20) respectively.

Conclusion: This study illustrates the high prevalence SDB in ALS patients with mild restrictive ventilatory impairment. Significant SDB may develop earlier than impairment of awake pulmonary function in ALS patients and treating this early may improve the quality of life of ALS patients. In addition, this study highlights the possible diagnostic value of PM in the ALS population.

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0689

THE INTERVENTION OF OREXIN SYSTEM IN PARKINSON'S DISEASE AND PROGRESSIVE SUPRANUCLEAR PALSY WITH HYPERSOMNIA

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Introduction: Although excessive daytime sleepiness (EDS) commonly appears in Parkinson's disease (PD) and its related disorders, the mechanism underlying the generation of this symptom remains unclear. Recently, the levels of CSF orexin and its relation to EDS in PD were examined. Cases of normal orexin levels in PD with hypersomnia, and undetectable low orexin levels in severe PD were reported. However, the results have been inconclusive.

Methods: We have measured CSF orexin in 200 patients with PD or progressive supranuclear palsy (PSP) so far. The majority of these cases showed normal levels of orexin (> 200 pg/ml). However, we experienced 7 cases with PD or PSP which showed low orexin levels under 110 pg/ml. We attempt to report these seven cases in this study.

Results: The 5 PD cases are 66.8 years old on average, 3 men and 2 women. The 2 PSP cases are both 74 years old, 1 man and 1 woman. All cases showed low orexin levels. In 2 cases of PD and 1 case of PSP, neurological symptoms occurred about 10 to 20 years after narcolepsy onset. As for the other 4 cases, PD symptoms occurred simultaneously with narcoleptic symptoms.

Conclusion: We think the former cases of narcolepsy coexisted with PD or PSP. While the narcoleptic symptoms in the latter cases were caused secondary to PD or PSP, these results suggest that the pathologic conditions of these neurodegenerative disorders cause neurological disorders in orexin system, and lead to hypersomnia. However, further clinical studies are needed to verify the results.

0690

COGNITIVE DYSFUNCTION IN MULTIPLE SCLEROSIS IS ASSOCIATED WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Cognitive dysfunction, including impaired attention, working memory, visual-spatial processing, and processing speed, af-

fects 42-70% of multiple sclerosis (MS) patients. Nonetheless, identification of strategies to minimize cognitive dysfunction in MS is hindered by a poor understanding of exacerbating factors. Although sleep disorders contribute to cognitive dysfunction in the general population and affect approximately 50% of MS patients, the relationship between cognition and sleep remains unstudied in MS. The aim of this ongoing study is to examine the relationships between sleep and cognitive function in patients with MS.

Methods: N = 13 MS subjects who were at high risk for obstructive sleep apnea (OSA, based on the STOP-Bang questionnaire), or those who expressed concerns about their sleep, underwent in-laboratory polysomnography and cognitive testing. Cognitive tests assessed working memory and auditory processing (Paced Auditory Serial Addition Test, PASAT); attention, visual tracking, and motor speed (Symbol Digit Modalities Test, SDMT); and visuo-spatial orientation (Judgement of Line Orientation Test, JLO). For all tests, higher scores indicate better functioning.

Results: The apnea-hypopnea index (AHI) correlated strongly with SDMT scores ($r = -0.73$, $p = 0.0050$) and PASAT scores ($r = -0.72$, $p = 0.0051$), though not significantly with JLO scores ($r = -0.44$, $p = 0.1286$). The oxygen desaturation index (ODI) correlated with SDMT ($r = -0.57$, $p = 0.0437$) and PASAT scores ($r = -0.69$, $p = 0.0093$). The total arousal index also correlated strongly with SDMT score ($r = -0.70$, $p = 0.0074$). In regression models that included a covariate for disability level (Expanded Disability Status Scale) or educational level, associations between AHI and PASAT scores, AHI and SDMT scores, and ODI and PASAT scores each retained statistical significance ($p < 0.05$).

Conclusion: Our findings suggest that sleep disturbances, and OSA in particular, could contribute to cognitive dysfunction—impaired working memory, attention, visual tracking, and visuo-spatial orientation—that are key aspects of morbidity borne by MS patients. If an underlying causal role exists, new opportunities may emerge to improve cognition in MS patients.

0691

QUALITY OF LIFE, SLEEP QUALITY AND SLEEP DISORDERS IN PARKINSON'S DISEASE

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Introduction: Parkinson's disease (PD) is characterized by tremor, rigidity, bradykinesia and gait instability. Non motor symptoms are related with PD, such as sleep disorders, depression, autonomic dysfunctions, hyposmia and cognitive deficits. All these aspects can influence the quality of life and sleep quality in PD patients. The objective of this work is to evaluate the relationship between quality of life, sleep quality and sleep disorders in PD patients.

Methods: A transversal study was conducted among 88 consecutive PD patients during a period of 21 months. They were followed in a specialized ambulatory of Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Brazil. Participants were submitted to a clinical evaluation with specialists in sleep medicine, movement disorders and psychiatry. A sleep study was performed and the following instruments were applied: Unified Parkinson Disease Rating Scale (UPDRS), Epworth Sleepiness Scale, Pittsburgh Sleep Quality Index (PSQI) and the Parkinson's Disease Questionnaire (PDQ-39).

Results: Higher scores on the PDQ-39 were observed in male patients ($p < 0.001$), unmarried ($p < 0.03$), subjects with insomnia ($p < 0.001$), restless legs syndrome (RLS) ($p < 0.01$), depression ($p < 0.01$) and psychotic disorder ($p < 0.02$). There were no differences among patients with sleep apnea and those with REM behavior disorder. We observed a positive correlation between the PDQ-39 and UPDRS scale ($r = 0.44$,

$p = 0.001$), Epworth Sleepiness Scale ($r = 0.32$, $p = 0.02$) and PSQI ($r = 0.42$; $p = 0.001$).

Conclusion: We observed a worse quality of life in men, unmarried, suffering from insomnia, RLS, depression and psychotic disorder. Moreover, there were positive correlations between quality of life and the sleep quality, daytime sleepiness and values on UPDRS.

Support (If Any): CNPq.

0692

EFFECTS OF DEEP BRAIN STIMULATION ON SLEEP IN PARKINSON'S DISEASE

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Introduction: Insomnia, daytime sleepiness, restless legs syndrome (RLS), sleep disordered breathing (SDB), and REM Behavior Disorder (RBD), are common in Parkinson's disease (PD). The purpose of this study was to learn how deep brain stimulation (DBS) used for treatment of Parkinson's disease affects these sleep problems in Parkinson's patients.

Methods: Subjects with PD who had undergone or were planning to undergo DBS surgery were eligible for this study. Patients were given sleep inventory questionnaires to assess degree of targeted sleep problems before and after surgery. Questionnaires included: the RBD Screening Questionnaire (RBDSQ), Mayo Questionnaire 1 for RBD, RLS Screening Questionnaire, IRLSSG RLS Rating Scale for Severity, Epworth Sleepiness Scale (ESS), PROMIS Sleep Disturbance Short Form (PSD-SF), PROMIS Wake Disturbance Short Form (PWD-SF), and Sleep Apnea Scale of Sleep Disorders Questionnaire (SA-SDQ). Medications before and after surgery were recorded.

Results: Initial results were from 4 males and 1 female who had undergone DBS surgery, including 4 patients with tremor predominant PD and 1 with familial PD. PWD-SF, PSD-SF, and ESS scores all improved after surgery ($n = 5$, $P < 0.05$). For the 4 subjects who had RBD, RBDSQ scores significantly decreased from 8.75 to 2.5 ($p < 0.05$). For 3 subjects with RLS, there was a trend for reduced severity ($p = 0.063$). SA-SDQ scores were unchanged ($p = 0.28$). Total daily levodopa dose after surgery was reduced ($p < 0.05$).

Conclusion: In this pilot sample of subjects with PD, several measures of sleep improved following DBS surgery, including RBDSQ score, and measures of sleep and wake disturbances. Changes may be a result of both changes in medication requirements and effects of brain stimulation. Further evaluation of the effects of DBS therapy on sleep may provide new insight into the pathophysiology of sleep disorders such as RBD and be useful for PD patients considering undergoing DBS surgery.

0693

CIRCADIAN RHYTHM DISRUPTION IN PROGRESSIVE SUPRANUCLEAR PALSY

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Introduction: The brainstem is amongst the first regions affected in individuals with Progressive Supranuclear Palsy (PSP). This region is responsible for a number of homeostatic physiological factors, including circadian rhythms. While brain stem degeneration has been well characterized in this population, at present there have been no investigations examining whether circadian activity rhythms (CARs) in individuals with PSP are negatively impacted. We hypothesized that CARs would be disrupted in individuals with PSP: more specifically, we expected a

flattened amplitude and smaller mesor as compared to controls which would be indicative of disease-related circadian dysregulation.

Methods: Individuals with a PSP diagnosis ($n = 7$; 5 men, mean age: 72.9) and clinically healthy older adults ($n = 6$; 4 men, mean age: 74.3) were recruited for this study. Participants wore AMI actigraph watches for 10 consecutive 24 hr periods and completed sleep diaries during the 10-day recording period. Using AMI software, we used the cosinor and averaged waveform analyses on the proportional integration data collection mode, to determine circadian activity amplitude and mesor.

Results: Individuals with PSP had significantly smaller CAR amplitude ($p = .001$) and mesor ($p = 0.006$) than healthy older adults.

Conclusion: Conclusions and future directions: In line with our proposed hypothesis, CARs are disrupted in individuals with PSP as compared to controls. These differences provide the first quantitative measures confirming previous anecdotal reports of greater sleep disturbances in this group. Recruitment for this study is ongoing. Future work includes augmenting the total number of participants in each group as well as directly imaging the brain stem to assess the neural correlates associated with these observed differences.

Support (If Any): Rainwater Foundation.

0694

HYPNOTIC USE AND FATIGUE IN PATIENTS WITH MULTIPLE SCLEROSIS

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Introduction: Fatigue affects up to 90% of multiple sclerosis (MS) patients. Despite recent evidence that sleep disturbances (reported by at least 50% of MS patients) are linked to MS-related fatigue, information regarding concomitant hypnotic use has received scant attention, and the relationship between hypnotics and fatigue in MS remains unstudied.

Methods: Data on hypnotic use frequency (never, occasionally, frequently, always), specific agents of choice, and clinical characteristics were extracted from medical records and a survey dataset from $n = 190$ MS patients, consisting of data regarding sleep quality, sleep quantity, nocturnal symptoms, fatigue level (Fatigue Severity Scale, or FSS), sleepiness (Epworth Sleepiness Scale), OSA risk (STOP-Bang questionnaire), and medication use.

Results: Nearly half of patients ($n = 89$, 47%) endorsed hypnotic use occasionally, frequently, or always. Over-the-counter (OTC) diphenhydramine-containing products accounted for the majority of hypnotic utilization, reported by $n = 47$ (25% of all subjects). Hypnotic use (yes/no) correlated with fatigue (Spearman $\rho = 0.28$, $p = 0.0002$), but not sleepiness. In regression models adjusted for age, gender, BMI, depression, number of nocturnal symptoms, STOP-Bang score, disability, sleep latency, and sleep duration, hypnotic use was associated with higher FSS scores (regression parameter = 0.58, $p = 0.0059$). In separate models adjusted for the same covariates, OTC hypnotic use, but not prescription hypnotic use, was associated with higher FSS scores (regression parameter = 0.54, $p = 0.0155$). Diphenhydramine use was independently associated with FSS scores in similar models (regression parameter = 0.52, $p = 0.0282$).

Conclusion: These data suggest that use of hypnotic agents, and particularly diphenhydramine-containing products, is highly prevalent among MS patients. Carry-over effects from such agents could contribute to daytime fatigue. Antihistamines also have the potential to cause psychomotor impairment, which may be exacerbated in patients at risk for impaired psychomotor performance due to their neurological condition. Efforts should be made to identify alternative approaches to improve insomnia among MS patients.

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0695

COMPARISON OF SELF-REPORTED SLEEP MEASURES FOR INDIVIDUALS WITH CHRONIC CENTRAL NERVOUS SYSTEM DYSFUNCTION

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Introduction: We previously identified discrepant findings among the Medical Outcomes Study Sleep scale (MOS-S) and the PROMIS short forms for sleep disturbance (PROMIS-SD) and sleep related impairments (PROMIS-SRI) in multiple sclerosis (MS) and spinal cord injury (SCI) patients. Specifically, the MOS-S indicated significant levels of difficulty with sleep for both of these groups, while PROMIS scores did not. Here we compare item-level responses for each sample in an attempt to explain this discrepancy.

Methods: Seven hundred adults (age 18 and older) with either MS ($N = 461$) or SCI ($N = 239$) enrolled in a longitudinal survey of self-reported health outcomes completed the MOS-S, PROMIS-SD, and PROMIS-SRI. The items of the three scales were examined to identify items with comparable wording. Participant responses for these items were dichotomized into low (MOS-S: none, little, or some of the time; PROMIS: not at all, a little, somewhat) and high (MOS-S: a good bit, most, or all of the time; PROMIS: quite a bit, very much) frequency responses. For each pair of items, the number endorsing frequent difficulties on the MOS-S and the PROMIS short form was compared using chi-square tests.

Results: Seven pairs of similarly worded items were identified. In both cohorts, a higher percentage of participants indicated frequent problems on the MOS-S compared to the PROMIS measures.

Conclusion: Participants were more likely to indicate frequent problems with sleep and sleep related problems on the MOS-S than on the PROMIS short forms, despite the fact that these measures were administered simultaneously. This may reflect the different number of response options available (MOS-S = 6, PROMIS = 5). It also may be a function of the different time frames measured (MOS-S = 4 weeks, PROMIS = 1 week). Further research is needed to determine the utility of both measures given the lack of consistency in responses.

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0696

AMYLOID BURDEN IN OBSTRUCTIVE SLEEP APNEA: PILOT STUDY

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Introduction: Recent epidemiologic evidences suggest that obstructive sleep apnea (OSA) may contribute to the development of dementia. Sleep apnea-related intermittent hypoxia facilitates amyloid overproduction, and sleep disruption leads to the impaired clearance of amyloid in brain. Amyloid deposition is a key pathology of Alzheimer disease (AD), and present 15 to 20 years before clinical onset of AD. Therefore excessive amyloid deposition or production is one of the possible linking mechanisms between OSA and AD. This study aims to explore the difference in amyloid burden using Pittsburgh Compound B (PiB) PET imaging in OSA and matched control group.

Methods: Subjects were selected among Korean adults who participated in the 6th biennial evaluation cycle of the Korean Genome and Epidemiology Study and underwent home portable polysomnography, brain MRI, and neuro-cognitive function test battery in years 2011-2012. Subject should be non-demented with their Z-scores on each cognitive test not less than -1.5 and normal brain MRI. Nineteen OSA subjects (apnea-hypopnea index, AHI ≥ 15 , 21.2 ± 5.1 ; 58.5 ± 4.1 years old; 9 male) and 19 control (AHI < 6 , 1.8 ± 1.3 ; 58.5 ± 4.2 years old; 9 male) underwent 60-min dynamic ¹¹C-PiB PET. Control subjects were matched with OSA according to the predefined criteria including age (± 2 years), gender, education, and ApoE genotype. Voxel-wise comparison of PiB-PET images between two groups was performed after spatial and count normalization with cerebellar gray matter as a reference. Covariates included the status of diabetes, hypertension, current smoking, alcohol drinking, mood and physical activities.

Results: OSA group showed higher PiB deposition in posterior cingulate, superior temporal, and orbitofrontal frontal gyrus (uncorrected $p < 0.001$).

Conclusion: The preliminary results suggest that OSA may be associated with higher amyloid burden compared with age, gender, education, and ApoE-matched control. Future longitudinal observation study with adequate statistical power is required.

0697

DISRUPTION OF SLEEP-WAKE CONTINUUM IN DEMENTIA AND MILD COGNITIVE IMPAIRMENT: MACROSTRUCTURAL AND MICROSTRUCTURAL FINDINGS

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Introduction: Mild Cognitive Impairment (MCI) defines an initial state in the process of cognitive impairment which is considered an interme-

diate stage towards dementia. Few works have focalized on sleep and its disorders in cognitive processes in this situation. Aim of our study was to evaluate sleep macro and microstructural variables in MCI subjects compared with cognitive intact elderly (HC) and Alzheimer's disease patients, and to correlate these parameters with neuropsychological tests.

Methods: Twelve MCI subjects (7F, 5M; mean age 73 ± 4) underwent PSG home recording. Sleep macrostructure and cyclic alternating pattern (CAP) were scored according with standard international criteria. According with previous findings we divided into subgroups based on daytime napping behaviour (> 60 minutes). MCI were compared with 14 HC and 20 mild AD, defined by a CDR score of 1, both age and sex-matched. Macro and microstructural parameters were correlated with neuropsychological scores and patients were evaluated after 12 months of follow up.

Results: We found no statistically significant macrostructural difference in MCI subjects compared with AD and HC. A trend of decreasing CAP time and CAP rate in MCI subjects compared with healthy controls emerged and, while A3 subtypes were increased in MCI compared with HC, A1 subtypes were decreased. Macro and microstructural variables in daytime- napping patients showed decreased nocturnal slow wave sleep and A1 subtypes. Single microstructural variable and neuropsychological test correlates and several sleep parameters (daytime napping, less sleep continuity) were different in MCI subjects that progress to AD.

Conclusion: Our data show that microstructural sleep variables correlates with cognitive process also in this condition and that sleep-wake cycle stability and sleep microstructure could be considered as biomarkers underlining neurodegenerative cognitive disorders, even if other studies in bigger population are needed.

0698

OBSTRUCTIVE SLEEP APNEA SCREENING AND PREVALENCE IN PATIENTS WITH ACUTE STROKE OR TIA AT UTAH VALLEY REGIONAL MEDICAL CENTER

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Introduction: A 2010 meta-analysis examined 29 studies of patients with acute stroke or transient ischemic attack (TIA) who were tested for sleep apnea. In the meta-analysis, the frequency of sleep apnea with an Apnea Hypopnea Index (AHI) > 5 was 72% and AHI > 20 was 38%. Based on extensive literature review, a process was developed to screen and test acute stroke/TIA patients at Utah Valley Regional Medical Center (UVRMC) for Obstructive Sleep Apnea (OSA).

Methods: To examine the outcomes of the initial year of screening acute stroke/TIA patients for obstructive sleep apnea (OSA) at UVRMC, data was collected on all patients referred by the Acute Stroke Services Team at UVRMC who received formal sleep testing. Demographic and polysomnography (PSG) data were analyzed to identify the prevalence and severity of OSA as well as possible contributing factors in this patient population.

Results: During the first year of screening, in-lab PSG testing was completed on 76 stroke patients representing 19.8% of 384 ischemic stroke/TIA patients seen by the stroke services. PSG results found 62 patients (81.6%) with an AHI > 5 and 36 patients (47.4%) with an AHI > 20 .

Conclusion: The AHI for acute stroke/TIA patients referred for sleep testing from UVRMC is comparable or exceeds the prevalence reported in the meta-analysis, possibly due to more rigorous screening and testing compared to some studies in the meta-analysis. These findings support the screening and testing of all acute stroke/TIA patients at UVRMC for sleep apnea. Further work is required to identify barriers to sleep testing and treatment compliance for stroke/TIA patients, which is potentially more

challenging in these patients. There is also insufficient knowledge on the short or long term benefits of treatment in acute stroke/TIA patients.

0699

WHEELCHAIR BASKETBALL IS THE BEST TREATMENT FOR RLS? PREVALENCE OF RESTLESS LEGS SYNDROME IN PARA-ATHLETES DURING BRAZILIAN WHEELCHAIR BASKETBALL LEAGUE

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Introduction: Restless legs syndrome (RLS) is characterized by unpleasant sensations, with circadian pattern, with prevalence between 3 and 15% in the general population. In approximately 30% of cases the RLS can be related to vascular injury in spinal cord, cervical spondylotic myelopathy, and syringomyelia. Although physical activity is a recognized factor that improves RLS in general population, few authors has been studying this kind of approach in restless legs syndrome after spinal cord injury (SCI). Authors investigated the prevalence of RLS in para-athletes (PA) after SCI during Brazilian Wheelchair Basketball League (BWCB).

Methods: This study was a cross-sectional study performed during the BWCB seasons between 2007 and 2011. 84 male athletes from different regions of Brazil with SCI were studied. All SCI occurred within two years or more. 62% of SCI was complete and 50% of SCI were between C5 and T8. 47.7% of SCI occurred by firearms and 87% of PA were paraplegics. A standard and validated questionnaire for RLS was used. No patient used medications to treat RLS.

Results: 67% PA had spasticity, 12% had paresthesia, and 14.3% had non-characterized pain in the lower limbs. No PA had criteria for RLS.

Conclusion: Although the prevalence of RLS in SCI patients is higher, our study shows no PA with RLS criteria. This study highlights the importance of physical activity to avoid RLS in patients after SCI.

0700

EFFECTS OF PROTON THERAPY ON SLEEP, FATIGUE AND QUALITY-OF-LIFE IN CHILDREN WITH CRANIOPHARYNGIOMA

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Introduction: Pediatric patients with craniopharyngioma are at increased risk of excessive daytime sleepiness (EDS), fatigue and a decline in quality of life (QoL) secondary to tumor location and treatment-related effects. Proton therapy may substantially improve patient-reported outcomes such as EDS, fatigue, and QoL. Here we describe EDS, fatigue, and QoL in children with craniopharyngioma, as reported by patients and their parents prior to proton therapy (baseline) and 3 months later.

Methods: At baseline, 30 patients with craniopharyngioma (ages 5-19 y; mean age 10.5 ± 4.5 y) completed the Epworth Sleepiness Scale (ESS), Multidimensional Fatigue Scale, and Pediatric Quality of Life Inventory (PedsQL4). Parents also completed the latter 2 instruments. These measures were repeated 3-months later, approximately 6 weeks after the completion of proton therapy. Wilcoxon signed-rank test was used to assess changes in scores between the 2 assessments.

Results: QoL improved from baseline to 3 months, as reported by patients and parents on the PedsQL4 ($p = 0.0001$ and $p = 0.0216$, respec-

tively). Although patients reported a subjective improvement in EDS, with a mean improvement of 1.6 on the ESS, the change was not statistically significant ($p = 0.0908$). Subjective fatigue, as reported by children and parents, also did not change ($p = 0.5501$ and $p = 0.1530$, respectively).

Conclusion: Patient and parental reports indicated improved QoL after proton therapy, with a subjective trend toward improved EDS. The 3-month evaluation occurred about 6 weeks after proton therapy was completed, which is typically a time of increased somnolence in children treated with conventional radiation therapy. Improvement in QoL and trending improvement in EDS may indicate improved outcomes in children with craniopharyngioma treated with proton therapy. We plan to collect additional data, which may assist with power to detect differences over time.

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0701

LOW-TO-MODERATE ALCOHOL CONSUMPTION IS ASSOCIATED WITH GREATER HIPPOCAMPAL VOLUME IN INDIVIDUALS WITH COMORBID CHRONIC INSOMNIA AND FIBROMYALGIA

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Introduction: Chronic insomnia is frequently comorbid with fibromyalgia. The cognitive activation theory of stress suggests rumination about physical symptoms, which is facilitated by memory processes subserved by the hippocampus, may lead to the cognitive hyperarousal suggested to initiate these disorders. Recent evidence suggests that low-to-moderate alcohol use is associated with lower fibromyalgia symptom severity than abstinence. Whether these differences may extend to brain morphology is unknown. We used structural MRI to investigate whether reported alcohol use was associated with differences in hippocampal volume in individuals with comorbid chronic insomnia and fibromyalgia.

Methods: Eighteen female adults aged 52.28 ± 16.34 years reported daily alcohol use and pain (VAS: 0-100) for 2 weeks and completed a structural MRI scan. Differences in average daily pain symptomatology were examined using a t-test. Hippocampal volume, normalized as a percentage of total gray matter volume, was compared in drinkers ($M = 0.74 \pm 0.69$ drinks per day, $n = 10$) and nondrinkers ($n = 8$) while controlling for depressive symptomatology, age, and MRI signal-to-noise ratio using one-way ANCOVA.

Results: Drinkers ($M = 40.91 \pm 19.19$) had significantly less pain symptomatology compared to nondrinkers ($M = 60.76 \pm 15.56$), $t(16) = 2.37$, $p < 0.05$, Cohen's $d = 1.14$. Drinkers ($M = 0.67 \pm 0.06\%$) had significantly greater right hippocampal volume compared to nondrinkers ($M = 0.62 \pm 0.06\%$), $F(1,13) = 4.95$, $p < 0.05$, Cohen's $d = 0.97$. A directionally similar, non-significant difference in left hippocampal volume was also noted (Cohen's $d = 0.70$; $p < 0.18$).

Conclusion: Significantly decreased pain symptomatology and increased right hippocampal volume was noted in individuals with comorbid chronic insomnia and fibromyalgia that endorsed low-to-moderate alcohol consumption compared to abstainers. However, the mechanism underlying this effect is unclear. Further investigation of the relationship between alcohol use and symptomatology in individuals with comorbid fibromyalgia and insomnia is warranted.

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0702

SLEEP DISORDERS IN HEADACHE PATIENTS REFERRED FOR POLYSOMNOGRAPHY

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Introduction: There is a known relationship between headaches and sleep disturbances. Sleep deprivation is an exacerbating factor for recurrent headaches. There are well known nocturnal headache syndromes. Patients with sleep disorders frequently complain of morning headaches. **Methods:** Retrospective study. Patients with the diagnosis of headache (ICD9 codes of 346.00 through 346.93 and 784.0), which include migraine headaches with and without auras, variants of migraines and chronic migraine headaches, who were referred to Texas Neurology Sleep Disorders Center from January 2009 to June 2011 were identified. Polysomnography study impression, as well as patient's headache diagnosis, and co-morbidities such as obesity, high blood pressure and depression were abstracted. Sleep disturbance symptoms that prompted the ordering of the sleep study, including fatigue, snoring, restless sleep and morning headaches were also recorded.

Results: There were 225 patients with headache qualified for the study, 164 (72.9%) females average age 42.3 (12.5 SD) years. 108 (48.0%) had obstructive sleep apnea, 24 (10.7%) had periodic limb movement disorder, 3 (1.3%) had other sleep disorders and 90 (40.0%) had no significant polysomnographic abnormalities. Most common symptoms associated with headaches in this group were fatigue 216 patients (96.0%); morning headaches 174 patients (77.3%), restless sleep 159 patients (70.6%) and snoring 144 patients (64.0%). Most common co-morbidities were obesity 113 (50.2%), hypertension 88 patients (39.1%) and depression 80 patients (35.5%). Logistic regression showed that factors associated with sleep apnea are age, sex, obesity and morning headaches.

Conclusion: Sleep disorders diagnosed by polysomnography are common in headache patients. Associated symptoms of fatigue, morning headaches, restless sleep and snoring as well as co-morbid obesity, hypertension and depression increase the possibility of finding a sleep disorder by polysomnography. Inquiring about sleep disturbance symptoms and polysomnography should be considered in patients with headaches. Sleep apnea is significantly associated with age, sex, obesity and morning headaches.

0703

RISK FACTORS ASSOCIATED WITH SLEEP DISTURBANCE FOLLOWING TRAUMATIC BRAIN INJURY

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Introduction: Sleep disturbance is common following traumatic brain injury (TBI), which may exacerbate a variety of co-morbidities and negatively impact rehabilitative treatments. There are paradoxical reports regarding the associations between inherent characteristics of TBI and sleep disturbance in TBI population. The current study was designed to explore the relationship between sleep disturbance and characteristics of TBI and identify the factors closely related to sleep disturbance in TBI population.

Methods: 98 TBI patients (72 males, mean age \pm SD, 47 ± 13 years) were recruited. Severity of TBI was evaluated based on Glasgow Coma Scale (GCS). All participants performed cranial computed tomography

and were examined on self-reported sleep quality, anxiety, and depression.

Results: 37 of 98 patients (38%) reported sleep disturbance following TBI. Insomnia was diagnosed in 28 patients (29%) and post-traumatic hypersomnia in 9 patients (9%). In TBI with insomnia group, 5 patients (18%) complained difficulty falling asleep only, 8 patients (29%) had difficulty maintaining sleep without difficulty in initial sleep and 15 patients (53%) presented both difficulty falling asleep and difficulty maintaining sleep. Risk factors associated with insomnia were headache and/or dizziness and more symptoms of anxiety and depression rather than GCS. In contrast, GCS was independently associated with the presence of hypersomnia following TBI. Furthermore, there was no evidence of an association between locations of brain injury and the presence of sleep disturbance after TBI.

Conclusion: Our data support and contribute to the evidence which indicates that TBI patients with insomnia are prone to suffer from concomitant headache and/or dizziness, report more symptoms of anxiety and depression and severe TBI patients are likely to experience hypersomnia.

0704

THE SATURATION IMPAIRMENT TIME AS A PREDICTOR OF OUTCOME IN TRAUMATIC BRAIN INJURY

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Introduction: Traumatic brain injury (TBI), particularly moderate to severe injury is perceived as a grave prognosis with a protracted and often poor recovery. In the last several years the literature shows that this may not be the case and that significant recovery is often achievable. Disorders of breathing during sleep may lead to intermittent hypoxia which may influence recovery.

Methods: Level II polysomnography was performed on seven patients (Age: mean (std) = 31 (6.7) years; range: 21-37) with acute moderate-severe TBI during acute neurorehabilitation at the Tampa VA Polytrauma Rehabilitation Center. The Apnea-Hypopnea Index was < 5 for all cases, with a mean (std) of 1.4 (1.05). The index of nocturnal levels of oxygen saturation, Saturation Impairment Time (SIT) index, were computed from pulse oximetry SpO₂ and compared with patient outcome measures. The SIT index is obtained by integrating SpO₂ over time below a pre-determined patient's baseline level during sleep. Here we used 90% desaturation as the baseline and applied logarithmic transformation to the SpO₂ integrals which were normalized by total sleep time. Pearson's correlation analyses were then performed between SIT index, the Disability Rating Scale (DRS), and the Functional Independence Measure (FIM).

Results: The SIT index trended toward negatively correlated with DRS at discharge (Corr. Coeff. = -0.68, $p = 0.09$). There was also a strong and significant correlation between the SIT index and FIM at discharge (Corr. Coeff. = 0.79, $p = 0.037$).

Conclusion: We hypothesized that a worsening SIT index would correlate with worsening DRS and FIM scores. However, the reverse was observed. This may be secondary to the small sample size and the absence of sleep disordered breathing (SDB) in our population. However, the SIT index may alternatively indicate an underlying aspect of neurological recovery producing variability without significant hypoxia. Further studies into this relationship with larger cohorts and patients with SDB are needed.

0705

SLEEP AND QUALITY OF LIFE IN THE SPIROMICS COHORT

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Introduction: Sleep disturbances are common in COPD patients and can affect overall quality of life. Large epidemiologic studies evaluating sleep in COPD are lacking. We evaluated self-reported sleep disturbances within the SPIROMICS cohort, an NIH funded prospective, multi-center trial with an aim of redefining COPD phenotypes (www.csc.unc.edu/spir). We hypothesized that patients with COPD would have more disturbed sleep than controls without COPD and that sleep disturbances would adversely affect quality of life.

Methods: 1,808 SPIROMICS subjects [mean (SD) age = 63.8 (9.3); 52.8% male; mean (SD) BMI = 28.1 (5.3)] completed baseline evaluations including smoking history (packs*years), sleep quality (Pittsburgh Sleep Quality Index; PSQI), risk for obstructive sleep apnea (OSA; Berlin Sleep Apnea Scale; BSAS), disease-specific quality of life (St. George's Respiratory Questionnaire; SGRQ) and lung function (forced expiratory volume 1 sec.; FEV1). Complete PSQI and BSAS data was available in 1,626 and 1,360 subjects. Complete baseline data was available in 1,061 subjects. Subjects were grouped by study strata (1 = non-smoking healthy control; 2 = smoking non-COPD control FEV1/FVC > 0.7; 3 = mild to moderate COPD FEV1 ≥ 50%; 4 = severe COPD FEV1 < 50%). A regression model was used to examine predictors of SGRQ, including gender, age, smoking, FEV1, PSQI total score, and BSAS risk group.

Results: Analyses of variance showed that non-smoker controls had less sleep disturbance (lower PSQI scores) than smokers (stratum 2) (4.5 ± .33 vs 6.4 ± .17) and COPD patients [strata 3 (6.3 ± .15) and strata 4 (6.3 ± .23); p's < 0.001]. Similarly, non-smokers had lower risk of OSA than smokers (stratum 2), (35.1% vs. 55.3%) and COPD patients [strata 3 (56.2%) and strata 4 (52.7%), p's < 0.002]. In the regression model age, gender, FEV1, PSQI and BSAS explained 51% of the variance in SGRQ.

Conclusion: Increased sleep disturbances in non-COPD smokers and COPD subjects are noted when compared to non-smoker healthy controls and affect QOL.

Support (If Any): (HHSN268200900013C-20C).

0706

A RANDOMIZED TRIAL OF COGNITIVE BEHAVIOR THERAPY AND ARMODAFINIL TO TREAT INSOMNIA AND DAYTIME SLEEPINESS IN CANCER SURVIVORS

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Introduction: Insomnia and fatigue are the most frequently reported side effects associated with cancer. Although cognitive behavioral therapy for insomnia (CBT-I) is effective in addressing difficulty initiating and maintaining sleep, it frequently results in (short-term) sleepiness and fatigue. This may make it difficult for cancer patients to adhere to treatment. This study examines whether a combination of CBT-I and a

wake-promoting medication (armodafinil) results in greater overall improvement in insomnia and fatigue symptoms among cancer survivors.

Methods: Eighty-eight patients were randomized to one of four treatment conditions: 1) CBT-I + placebo (CBT+P), 2) CBT-I + armodafinil (CBT+M), 3) Placebo only (P) and 4) armodafinil only (M). CBT-I was delivered in 7 weekly one-hour individual therapy sessions (3 in person, 4 via telephone). Pre-post findings on sleep diary-measured sleep latency (SL), wake after sleep onset (WASO), total sleep time (TST), and daytime sleepiness measured by the Epworth Sleepiness Scale (ESS), are reported.

Results: The mean age of the group was 56 yrs, 88% were female and the majority of patients (68%) had breast cancer. ANCOVA was performed adjusting for baseline severity. Compared to the placebo group, patients in the CBT+P and CBT+M groups reported a significant reduction in SL with effect sizes of 0.67 and 0.58, respectively. There was a significant reduction in WASO in the CBT+M group only (p = .02). TST increased in the M group, but not in the CBT+P or CBT+M groups. There were no statistically significant reductions in daytime sleepiness (ESS) observed for any of the groups.

Conclusion: CBT-I alone and in combination with armodafinil was able to produce statistically and clinically significant improvement in self-reported sleep. The addition of armodafinil did not appear to enhance the effect of CBT-I via a reduction in daytime sleepiness. Analyses are ongoing to examine the impact of armodafinil on CBT-I compliance.

Support (If Any): This study was supported by a grant from NCI (R01CA126968) and study medication was provided by Teva Pharmaceutical.

0707

HEMODIALYSIS DECREASES OVERNIGHT ROSTRAL FLUID SHIFT AND IMPROVES OBSTRUCTIVE SLEEP APNEA IN OVERHYDRATED PATIENTS WITH END STAGE RENAL DISEASE

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Introduction: Obstructive sleep apnea (OSA) is more prevalent in end stage kidney disease (ESKD) patients than in the general population, and may contribute to their increased cardiovascular morbidity. Recent observations suggest a role of overnight rostral fluid shift (ORFS, i.e., fluid displacement from the legs to the neck soft tissue) in the genesis of OSA in otherwise healthy subjects, in heart failure patients, and in hypertensive patients with venous insufficiency. We aimed to investigate the hypothesis that ORFS is increased with overhydration and influences the severity of OSA in ESKD patients on intermittent ambulatory hemodialysis (HD).

Methods: The severity of OSA was assessed during two consecutive attended polysomnographies (PSG), performed the night before and after an HD session and expressed as index of obstructive apneas and hypopneas per hour (OAH). Total body overhydration (TBOH) and leg fluid volume were evaluated by bioimpedance. Neck circumference was assessed before and after each PSG.

Results: 17 patients were analyzed. Mean (SD) OAH was 46.8 (22.0)/h at baseline (pre-HD). Overall, total leg water volume decreased from mean (SD) 10.28 (1.90) L in the evening to 9.25 (1.81) L in the morning, corresponding to a mean overnight rostral fluid shift volume (ORFS) of 1,026 (460) ml (p < 0.001); in the meantime, neck circumference increased by 0.82 (1.11) cm. The ORFS volume was correlated with TBOH (r2 = 0.155, p = 0.021). HD reduced ORFS from 1,270 (410)

ml pre-HD to 780 (380) ml post-HD, $p < 0.001$. 11 patients were significantly overhydrated before HD, with a mean (SD) TBOH of $+ 2.67$ (1.38) L. In these patients, HD led to a significant improvement in OAHl decreasing from 53.2 (21.6)/h pre-HD to 40.6 (18.4)/h post-HD ($p < 0.001$). This was associated with a reduction of TBOH by 1.39 (0.90) L and ORFS by 690 (190) ml. In the remaining 6 patients, who were not overhydrated at baseline, OAHl was not influenced by HD.

Conclusion: Overhydration in hemodialysis patients yields an increased overnight rostral fluid shift which seems to be associated with increased OSA severity.

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0708

CIRCADIAN AND ENERGY METABOLISM GENE POLYMORPHISMS ARE ASSOCIATED WITH MEASURES OF SLEEP TIMING AND CHRONOTYPE AMONG ADULTS WITH HIV/AIDS

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Introduction: Circadian and energy metabolism genes have been associated with sleep timing in prior animal and human research. This study describes objectively measured and subjectively reported sleep-wake activity rhythms in adults living with HIV/AIDS, and associations with polymorphisms in circadian and energy metabolism genes.

Methods: A convenience sample of 279 adults (188 men, 70 women, and 21 transgender) with HIV/AIDS was recruited from HIV clinics and community sites in the San Francisco Bay Area. A wrist actigraph was worn for 72 hours to estimate acrophase, Pittsburgh Sleep Quality Index items assessed usual bed and wake times, and an item from the Horne-Ostberg Scale was used to assess chronotype (morning vs. evening). Genotyping was conducted for 11 candidate genes involved in sleep-wake cycles and energy metabolism: circadian locomotor output cycles kaput (CLOCK), period (PER1, PER2, PER3), cryptochrome (CRY1), adiponectin (ADIPOQ), ghrelin (GHRL), leptin (LEP), lamin A/C (LMNA), peroxisome proliferator-activated receptor alpha (PPARA) and gamma (PPARG).

Results: Mean acrophase was 14:54 (SD 1:32), mean bedtime was 22:35 (SD 1:37), mean final wake was 7:04 (SD 1:51), and 59% considered themselves a morning type. Acrophase and chronotype did not differ by gender and were not significantly associated with age (mean 45.1, SD 8.4, range 22-77 years). Controlling for population substructure and self-reported race, final wake time and chronotype were both associated with ADIPOQ rs3821799 and rs6773957, wake time was also associated with ADIPOQ rs182052 and rs15011299, and bedtime was associated with ADIPOQ rs12495941. Both chronotype and acrophase were associated with PPARA rs4253776, both wake time and acrophase were associated with PER3 rs707465, and final wake time was associated with GHRL rs26802.

Conclusion: Findings from this study of an HIV chronic illness population strengthens the evidence for an association between sleep-wake activity patterns and genes for energy metabolism and circadian rhythms.

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0709

SLEEP CHARACTERISTICS AMONG BLACKS WITH METABOLIC SYNDROME

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Introduction: Sleep among blacks with metabolic syndrome is not well characterized. Our study examined sleep characteristics of black men and women with a diagnosis of metabolic syndrome.

Methods: The present study utilized data from the Metabolic Syndrome Outcome Study (MetSO), an NIH-funded cohort study of blacks with metabolic syndrome (N = 1,035). Patients [mean age = 62 ± 14 years; female = 71%] were diagnosed with metabolic syndrome using criteria articulated in the joint interim statement for harmonizing the metabolic syndrome. They provided self-reported data including sleep habits and insomnia symptoms. They were administered the Apnea Risk Evaluation System (ARESTM) to ascertain risk of obstructive sleep apnea (OSA). Patients with a score of ≥ 6 on the ARES scale were considered at high OSA risk, based on validation studies.

Results: Of the sample, 60% were diagnosed with diabetes; stroke, 10%; heart disease, 31%; hypertension, 93%; overweight/obese, 90%. Based on ARES data, 48% were at risk for OSA. Analysis also showed that 53% reported feeling sleepy during the day, and 10% had an insomnia diagnosis. Specific insomnia symptoms included difficulty falling asleep (38%), difficulty maintaining sleep (42%), early morning awakening (46%); 53% reported daytime naps, and 12% used sleep medication. Prevalence of short sleepers (≤ 6 hrs) and long sleepers (≥ 9 hrs), referenced to healthy sleepers (7-8 hrs), was 70% and 19%, respectively. Based on chi-squared analysis, there was significant difference between males and females in regard to reported daytime sleepiness (41% vs. 56%; $\chi^2 = 7.736$, $p < 0.05$), difficulty falling asleep (34% vs. 41%; $\chi^2 = 5.252$, $p < 0.05$), and daytime naps (60% vs. 50%, $\chi^2 = 8.338$, $p < 0.05$). No other significant gender differences were observed.

Conclusion: Our findings suggest that a large number of blacks with metabolic syndrome experience insomnia symptoms, use sleep aids, and are both short and long sleepers. These sleep-related problems are associated with a myriad of chronic diseases, which have important clinical implications for disease management.

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0710

SLEEP DISTURBANCE, SLEEP RELATED SYMPTOMS AND BIOLOGICAL RHYTHMS IN HEART FAILURE PATIENTS WHO HAVE INSOMNIA

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Introduction: Poor sleep and related symptoms are common in heart failure (HF) and likely associated with circadian dysregulation. However, little is known about the associations between symptoms and biomarkers of dysregulation. The purpose was to examine the associations between sleep quality, sleep-related symptoms and the ratio between day/night urinary cortisol, catecholamines, and night/day melatonin among patients with stable HF.

Methods: The sample included 43 patients (M age = 59.4 ± 15.5 ; 46.5% male) with stable NY Class II-IV HF enrolled in a randomized controlled trial of cognitive behavioral therapy for insomnia (CBT-I) (CBT-

I or attention-control) and had an insomnia severity index > 7 . Urine samples were obtained in the afternoon and from bed time to wake time and analyzed for cortisol, catecholamines, and melatonin. The day/night cortisol and catecholamine ratios and the night/day melatonin ratio were computed and log transformed. Sleep quality, insomnia severity, anxiety depression, sleepiness, and self-reported physical function were obtained. Wake after sleep onset (WASO) was obtained by actigraphy.

Results: At baseline, age was associated with night/day melatonin ($r = 0.37$, $p = .03$), but there were no statistically significant correlations between age, gender or comorbidity and other ratios. Poor sleep quality, fatigue, and depression were negatively associated with cortisol ratio ($r = -0.39$, -0.56 , -0.51 , all $p < .05$), and WASO and physical function were associated with the epinephrine ratio ($r = -0.53$ and 0.38 , $p < .05$), after controlling for age. Improvements from baseline to post intervention in sleep quality ($r = -0.290$, $p = .07$) and fatigue ($r = -0.414$, $p = .013$) were associated with cortisol ratio. There were no statistically significant effects of CBT-I on the biomarkers.

Conclusion: Sleep quality and sleep-related outcomes are associated with circadian dysregulation among patients with stable HF. Future study is needed of the extent to which treatment of sleep disturbance may improve these biomarkers.

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0711

THE CONTRIBUTION OF SHORT SLEEP DURATION TO ALL-CAUSE MORTALITY IN CARDIOMETABOLIC DISORDERS

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Introduction: Hypertension and diabetes are well-established risk factors for cardiovascular morbidity and mortality. Short sleep duration has been associated with these risk factors and may play a role in mortality risk. We examined the joint effect of cardiometabolic disorders and objective short sleep duration on mortality.

Methods: We addressed this question in the Penn State Adult Cohort, 1741 men and women who were studied in the sleep laboratory and were followed-up for 18 years (men) and 14 years (women). Hypertension was defined as systolic blood pressure ≥ 90 mmHg / diastolic blood pressure ≥ 140 mmHg or use of antihypertensive medication and diabetes as fasting blood glucose ≥ 126 mg/dL or treatment for diabetes. Polysomnographic sleep duration was classified into two categories: ≥ 6 hours (top 50% of the sample) and < 6 hours (bottom 50% of the sample). We controlled for sex, age, race, apnea-hypopnea index, depression, alcohol, smoking, and obesity.

Results: The mortality rate was 21.8%. The odds of mortality associated with cardiometabolic disorders were 3.16 [95% CI (2.40-4.16)], while those associated with short sleep duration were 2.92 [95% CI (2.29-3.73)]. Compared to the ≥ 6 hour sleep duration group without cardiometabolic disorders, the highest odds of mortality were in the < 6 hour sleep duration group with cardiometabolic disorders [OR (95% CI) 5.90 (4.06-8.59)], followed by the ≥ 6 hour sleep duration group with cardiometabolic disorders [OR (95% CI) 2.04 (1.35-3.10)]. In fully adjusted models, the < 6 hour sleep duration group with cardiometabolic disorders remained significantly associated with mortality [OR (95% CI) 2.07 (1.33-3.20)].

Conclusion: Short sleep duration in individuals with cardiometabolic disorders is associated with increased odds of mortality. Future studies should examine whether lengthening sleep duration in these individuals, which might be biologically driven, behaviorally determined, or a marker of the severity of cardiometabolic disorders, reduces odds of mortality.

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0712

THE ASSOCIATION BETWEEN SLEEP CHARACTERISTICS AND PROTHROMBOTIC MARKERS IN A POPULATION BASED SAMPLE: CHICAGO AREA SLEEP STUDY (CASS)

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Introduction: Short sleep duration and poor quality sleep are associated with coronary heart disease (CHD) mortality; however, the pathophysiologic process underlying the association remains unclear. Sleep apnea is associated with the formation of thromboses, the vascular occlusive process in CHD and stroke. It is not known whether sleep duration and quality are associated with prothrombotic biomarkers in adults with a low probability of apnea.

Methods: Men and women aged 35-64 years old who were recruited from the community using commercial available telephone lists and had an apnea hypopnea index < 15 after one night of screening with the ApneaLink™ home detection system were included ($n = 556$). Mean sleep duration and percentage were determined from 7 days of wrist actigraphy. Duration was analyzed both continuously and categorically (< 6 hours, 6 to 8 hours [referent], and 8 or more hours). Daytime sleepiness was estimated using the Epworth Sleepiness Scale. Blood samples were collected from participants who had fasted for at least 12 hours. Factor VIII (FVIII), von Willebrand factor (VWF), thrombin antithrombin complexes (TAT), and plasminogen activator inhibitor-1 (PAI-1) were measured. We used logistic regression to model the association between each sleep characteristic and an elevated likelihood of thrombosis (defined as a value in the uppermost quartile).

Results: Sleep duration, percentage, and daytime sleepiness were not associated with elevated FVIII, vWf or TAT. Sleep percentage was modestly inversely associated with elevated PAI-1 (odds ratio = 0.77, 95% confidence interval: 0.61-0.98 per 4.8%) following adjustment for age, race/ethnicity, sex, diabetes, hypertension and BMI. Findings were similar when we restricted to participants with AHI < 5 .

Conclusion: There is limited evidence of an association between impaired sleep and prothrombotic markers. In adults who do not have sleep disorders, short sleep and poor quality sleep may be associated with CHD through alternate pathways.

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0713

POOR SLEEP QUALITY IS A SUPPLEMENTARY CARDIOVASCULAR RISK FACTOR IN HYPERTENSION

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Introduction: Poor sleep quality, depression and hypertension (HT) might be associated. All the three conditions are considered as risk factors for developing serious cardiovascular diseases, such as coronary heart disease and myocardial infarction. Our aim is to identify if poor sleep quality and/or depression represent supplementary cardiovascular risk factors in HT.

Methods: In this cross-sectional study, 134 essential HT patients (72 females) were recruited at the Outpatient Hypertension Unit, University

of Pisa, Italy. Sleep quality (Pittsburgh Sleep Quality Index [PSQI]), depression (Beck Depression Inventory [BDI]), cardiovascular risk (Framingham Risk score [FR]) and blood pressure (Systolic and Diastolic [SBP, DBP]) were evaluated. PSQI and BDI scores were transformed in dichotomous variables (1 for scores lower than 5 and 10, respectively, and 2 otherwise). FR was submitted to two ANOVA with gender and either PSQI or BDI as between factor and age, SBP and DBP as covariates.

Results: A significant effect of both gender ($p < 0.001$) and PSQI ($p < 0.05$) was found in the first ANOVA. FR scores of males were significantly higher than female scores. For PSQI, poorer sleep quality was associated with significantly higher FR scores. In the second ANOVA a significant effect of gender ($p < 0.001$) and a tendency toward significance ($p < 0.07$) of BDI were found. FR scores were higher for higher BDI scores, although not significantly.

Conclusion: These preliminary results allowed us to draw two main conclusion: (i) poor sleep quality is an independent factor in modulating cardiovascular risk in HT; (ii) depression seem to be dragged by poor sleep quality (PSQI scores and BDI scores were significantly correlated, $R = 0.5$, $p < 0.001$) in heightening the cardiovascular risk. In conclusion, the results of this study could help to develop specific therapeutic strategies for HT, which should include hypnotic treatment in order to reduce the cardiovascular risk.

0714

THE IMPACT OF INSOMNIA ON DEVICE ACCEPTANCE AND QUALITY OF LIFE IN CARDIAC PATIENTS LIVING WITH AN IMPLANTABLE CARDIOVERTER DEFIBRILLATOR (ICD)

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Introduction: How well patients adjust to living with an implantable cardioverter defibrillator (ICD) is largely influenced by psychosocial factors. Once such factor, insomnia, is established as having a deleterious effect on the quality of life of cardiac patients generally, and represents a significant comorbidity in patients living with an ICD. Furthermore, recent research has increasingly focused on device-specific adjustment in patients with cardiac implantable devices. 'Device acceptance' refers to the psychological accommodation and understanding of the device and its benefits (Burns et al., 2005). The present study investigated how device acceptance and patients' health-related quality of life are impacted by sleep disturbance.

Methods: A cross-sectional design was employed examining symptoms of insomnia, health-related quality of life and device acceptance in a cohort of 256 patients living with an implantable cardioverter defibrillator (82% male; mean age 67.78 years, SD = 12.18). The majority of patients had a history of coronary artery disease, and ischaemic heart disease was the most common pathology leading to ICD implantation. The Sleep Condition Indicator (SCI) questionnaire (Espie et al., 2012) was used to measure sleep quality, and permitted evaluation of symptoms against DSM-5 criteria for insomnia disorder (ID). Additional questionnaires included the HeartQoL (Oldridge et al., 2012) and the Florida Patient Acceptance Survey (FPAS) (Burns et al., 2005).

Results: With the application of DSM-5 criteria, 13.2% (34/257) of ICD patients screened as having possible insomnia disorder (ID). Males (23/201) were more frequently identified than females (11/46) to be at risk for possible ID, however this difference was not significant ($p = 0.7$). Both sleep quality ($p < 0.05$) and ID 'caseness' ($p < 0.001$) were associated with poorer device acceptance. Similarly, both insomnia symptoms

($p < 0.05$) and ID 'caseness' ($p < 0.001$) were associated with poorer health-related quality of life in this sample of cardiac patients.

Conclusion: Sleep disturbance adversely impacts the adjustment of cardiac patients living with an ICD, with respect to both quality of life and device acceptance. Accordingly, to optimise the benefits ICD patients derive from this technology, programmes of care should incorporate access to behavioural interventions targeting insomnia in this vulnerable population.

0715

SHOCK ANXIETY PREDICTS SLEEP ONSET LATENCY AND SLEEP QUALITY IN PATIENTS WITH IMPLANTABLE CARDIOVERTER-DEFIBRILLATORS (ICDS)

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Introduction: Implantable cardioverter-defibrillators (ICDs) use pacing and high-energy shocks to terminate fatal arrhythmias. Experience of an ICD shock can be traumatic; fear of shock is associated with poorer quality of life and negative health outcomes, notably sleep disturbance. However, the extent to which sleep disturbance in patients with ICDs is attributable to shock-related fears, instead of other psychological factors (e.g., depression) is unknown. This study examined sleep disturbance and its relationship to shock-specific anxiety and depressive symptoms in patients with ICDs.

Methods: 45 patients (age = 61.5 ± 12.4) with ICDs completed sleep diaries for 14 days and questionnaires to assess for depressive symptoms (Beck Depression Inventory-II; BDI-II) and fear of ICD shock (Florida Shock Anxiety Scale; FSAS). 6 hierarchical regression models were run controlling for age (block 1), with FSAS score (block 2) and BDI-II score (block 3) predicting diary-derived means and individual standard deviations (ISDs; measures night-to-night variability) for sleep onset latency (SOL), waketime after sleep onset (WASO), and sleep quality rating (SQR).

Results: M FSAS score = 17.6 ± 7.7 ; M BDI-II score = 10.5 ± 9.9 . Bonferroni corrections were used, alpha level for significance = .008. The adjusted block 2 model with FSAS scores predicting longer mean SOL ($R^2 = .28$) was significant. Adding BDI-II score in block 3 significantly increased explained variance in models for mean SOL ($R^2 = .41$), variability in SOL ($R^2 = .28$), and mean SQR ($R^2 = .49$). No other models were significant.

Conclusion: Greater shock anxiety predicted increased difficulty falling asleep, but presence of depressive symptoms had the greatest influence on sleep onset difficulties and sleep quality ratings. In cardiology clinics, ICD-related anxieties can be addressed with information and management strategies, while depressive symptoms may indicate consideration of pharmacological or therapy options. Our findings suggest that ICD patients may present with both shock anxiety and depressive symptoms that significantly relate to sleep difficulties. Multi-disciplinary care for ICD patients is warranted.

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0716

SLEEP QUALITY AND CARDIAC FUNCTION IN PATIENTS WITH HEART FAILURE AND SLEEP-DISORDERED BREATHING WERE IMPROVED BY LEG THERMAL THERAPY: A NOVEL ANALYSIS BASED ON POLYSOMNOGRAPHY

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Introduction: We previously reported favorable effects of leg thermal therapy (LTT), which warms only lower legs, on sleep problems in patients with congestive heart failure (CHF). Several studies indicated that deeper sleep in CHF patients might have cardioprotective effects because sympathetic activities decreased during deep sleep. Because the effects of amelioration of sleep quality by LTT on cardiac function needed to be clearer, we utilized a novel technique to predict cardiac function by analyzing the lag-times between airflow changes and fingertip oxygen saturations on polysomnography in patients with sleep-disordered breathing (SDB) and CHF. The lag-times indicate circulatory times of oxygenated blood from lung to fingertip, and thus it well correlated to cardiac function. We aimed to study whether the improvement of sleep quality by LTT affected on cardiac function using this technique.

Methods: Seventeen stable CHF patients with SDB (male: 13, age: 54 ± 13 yo.) underwent 15 minutes leg-warming (45°C) followed by 30 minutes insulation 3 nights. We conducted overnight polysomnography before and after 3 nights LTT. From polysomnography data, we calculated lag-time using a newly developed algorithm that automatically measures the time difference between starting points of nasal airflow and fingertip oxygen rise after desaturation.

Results: LTT significantly decreased sleep stage N1 (21.3 ± 11.5 to 16.9 ± 10.0%, $p = 0.02$) and tended to increase sleep stage N2 (60.1 ± 12.2 to 63.7 ± 8.3%, $p = 0.08$). In contrast, LTT did not influence sleep stage N3 and REM sleep. Importantly, favorable changes in sleep stage N1 and N2 significantly related with improvement of lag-times indicating improvement of cardiac function. ($r = 0.48$ $p = 0.05$, $r = -0.51$ $p = 0.04$; respectively).

Conclusions: Close correlation between amelioration of sleep quality and improvement of cardiac function by LTT in the CHF patients with SDB could be uncovered by our novel and practical analysis based on polysomnography data. LTT may become a useful home complementary therapy for CHF with SDB.

0717

THE CONTRIBUTION OF SHORT SLEEP DURATION TO INCIDENT STROKE IN CARDIOMETABOLIC DISORDERS

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Introduction: Hypertension and diabetes are well-established risk factors for cardiovascular morbidity and mortality. Short sleep duration has been associated with these risk factors and may play a role in increasing stroke risk. We examined the joint effect of cardiometabolic disorders and short sleep duration on incident stroke.

Methods: We addressed this question in the Penn State Adult Cohort, 1701 men and women studied in the sleep laboratory that did not have stroke at baseline and were followed-up after about 15 y. Hypertension was defined as systolic ≥ 90 mmHg / diastolic ≥ 140 mmHg blood pressure or antihypertensive medication use and diabetes as fasting blood glucose ≥ 126 mg/dL or treatment for diabetes. Polysomnographic sleep duration was classified as ≥ 6 h (top 50% of the sample) and < 6 h (bottom 50% of the sample). We controlled for sex, age, race, apnea-hypopnea index, depression, alcohol, smoking, and obesity.

Results: The rate of incident stroke was 5.8%. The odds of stroke associated with cardiometabolic disorders were 2.75 [95% CI (1.65-4.58)], while the odds associated with short sleep duration were 1.79 [95% CI (1.17-2.72)]. Compared to the ≥ 6 h sleep duration group without cardiometabolic disorders, the highest odds of stroke were in the < 6 h sleep duration group with cardiometabolic disorders [OR (95% CI) 3.86 (1.94-7.67)], followed by the ≥ 6 h sleep duration group with cardiometabolic disorders [2.48 (1.18-5.20)]. Fully adjusted models showed that in subjects with cardiometabolic disorders the odds of stroke were 2.50 (1.17-5.35) in the < 6 h group and 2.14 (0.99-4.63) in the ≥ 6 h group.

Conclusion: Short sleep duration in individuals with cardiometabolic disorders is associated with increased odds of stroke. Future studies should examine whether lengthening sleep duration in these individuals, which might be biologically driven, behaviorally determined, or a marker of the severity of cardiometabolic disorders, reduces the risk for stroke.

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0718

30-MINUTE ESTIMATES OF HABITUAL SLEEP DURATION REFLECT ELEVATIONS IN HBA1C: RESULTS IN A BIRACIAL, WORKING POPULATION

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Introduction: Many studies have shown associations between reported short sleep durations and poor glycemic control. In this study, we examined whether the risk for elevated HbA1c can be detected when individuals in a population are asked to make 30-minute discriminations in their habitual sleep duration.

Methods: Subjects were 1,576 working adults (58.1% women; 58.2% African American) at an urban University. Mean age and BMI were 48 (SD = 12) and 30.3 (SD = 6.8), respectively. None carried a diagnosis of diabetes when enrolled; mean HbA1c was 5.4%; 81 were found to have values $\geq 6.0\%$ when tested. All answered a question about habitual sleep duration over the preceding 6 months. Answers used 30-min anchors (e.g., 5, 5 ½, 6, 6 ½, etc), ranging from 4 to 11. We examined the effect of varying threshold for short sleep in relation to HbA1c $\geq 6.0\%$.

Results: Mean hrs of reported sleep was 6.7 (SD = 1.1). Odds Ratios (95% CI) for HbA1c $\geq 6.0\%$ for each habitual sleep duration threshold (odds for those below threshold relative to those reporting at least those number of hours of sleep) are shown below: < 5.5 hrs (3.10 [2.06-4.65]); < 6.0 hrs (2.11 [1.46-3.05]); < 6.5 hrs (1.71 [1.22-2.39]); < 7.0 hrs (1.61 [1.15-2.26]); < 7.5 hrs (1.46 [0.98-2.18]); < 8.0 hrs (1.26 [0.75-2.10]).

Conclusion: The vagaries and imprecision of self-reported sleep duration notwithstanding, these data suggest that individuals' perceptions of 30-minute differences of habitual sleep duration were associated with elevated HbA1c in a graded manner. Self-reports cannot substitute for objective measures of true sleep duration. On the other hand, if a population's graded perception of their own sleep duration is so sensitive for glycemic risk, public health recommendations for adequate sleep durations need not be scaled at the integer level.

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0719

DIABETES CONTROL ON SLEEP IN PATIENTS WITH TYPE 2 DIABETES

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Introduction: Sleep is an important indicator for quality of life. Patients with diabetes often have sleep disorders, especially symptoms of insomnia or sleep apnea. Status of diabetes control may contribute to sleep disorders. This study used a longitudinal design to explore the role diabetes control plays in sleep quality. Patients with type 2 diabetes mellitus were recruited from a pool of the Diabetes Care Network (DCN) in endocrine outpatient clinics of a medical center.

Methods: Two hundred and seventy-five patients (124 males and 151 females) aged 33-86 years (mean \pm SD = 61.8 \pm 10.4) in the DCN were sampled and their diabetes control were retrospectively retrieved from medical records for 1 year. The Pittsburgh Sleep Quality Index (PSQI \geq 5) and the Epworth Sleepiness Scale (ESS \geq 10) were used to assess sleep quality and excessive daytime sleep. Statistic software of SPSS AMOS 17.0 was used for data analyses.

Results: 76.7% of patients had poor glycemic control (HbA_{1c} $>$ 7) with a mean of 8.2 \pm 1.7. The majority of participants slept 6-7 hours (35.8%) and 55.8% were classified as having poor quality of sleep. In contrast, only 33.2% claimed having more than 7 hours of sleep a night, and 24.6% were classified as having excessive daytime sleep. The leading causes to disturb night time sleep perceived by current participants were nocturia (53.5%), can't get to sleep within 30 minutes (28.4%), and wake up in the middle of night (21.2%). After controlling for age and gender, patients with poor lipid control had higher risk (OR = 2.696, p = .025) of poor sleep; patients with poor glycemic control had more excessive daytime sleep (B = 1.369, p = .033).

Conclusion: Nocturia is the most bothersome symptom during night-time sleep. Poor lipid and glycemic control is associated with sleep quality and excessive daytime sleep. Findings from this study provide information about the control and severity of type 2 diabetes on sleep.

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0720

IRREGULARITY IN SLEEP SCHEDULES AND INSULIN RESISTANCE INDEPENDENTLY ASSOCIATE WITH HIPPOCAMPAL VOLUME

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Introduction: Sleep disruptions in humans relate to impairments in cognitive performance and functional alterations in the hippocampus. Insulin resistance (IR), a risk factor for cognitive decline and hippocampal atrophy, is also linked to sleep disturbances. We examined whether hippocampal volume is associated with individual differences in sleep characteristics (average sleep duration, bedtime and awakening time, and intra-individual variability in these indices) as well as IR, and if both, whether IR accounts for the effects of these sleep differences on hippocampal volume.

Methods: Participants were 435 healthy midlife volunteers (mean age 42.7 \pm 7.3 yrs [range: 30-54]; 53% Female; 84% White). Sleep duration (hrs), bedtime, and awakening time were averaged over 7 nights of actigraphy monitoring, and variability was quantified as the within-person

standard deviation over 7 nights for each sleep parameter. FreeSurfer was used to derive volume measures via a priori segmentation of anatomically defined hippocampal regions. Participants provided a blood sample from which IR was quantified via the homeostatic model assessment of IR (HOMA-IR).

Results: Hierarchical regression analyses controlling for age, sex, race and intracranial volume showed mean sleep duration, bedtime, and awakening time, as well as night-to-night variability in sleep duration were unrelated to hippocampal volume (p 's $>$.05). In contrast, greater bedtime variability and variability of awakening time were each associated with reduced hippocampal volume (β = -.11, p = .003; β = -.08, p = .033, respectively) as well as HOMA-IR (β = .12, p = .008; β = .15, p = .001, respectively). IR was also associated inversely with hippocampal volume (β = -.10, p = .011), but did not mediate the relationship between sleep time (bedtime and awakening time) variability and hippocampal volume (p 's $>$.05).

Conclusion: Irregularity of sleep schedules and IR independently covary with the morphology of the subcortical brain structure important for memory, which is known to be affected by disrupted sleep dynamics.

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0721

AN INVESTIGATION OF THE ASSOCIATIONS AMONG SLEEP DURATION AND QUALITY, TYPE 2 DIABETES MELLITUS, AND INSULIN RESISTANCE

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Introduction: There is increasing evidence suggesting a link between short sleep duration and the onset of metabolic disease but little is known about sleep quality in relation to newly diagnosed patients with type 2 diabetes mellitus and body mass index. We aimed to examine the direct and indirect associations of sleep duration and quality with insulin resistance whilst considering body mass index (BMI) as a potential mediator in a large sample of patients with newly diagnosed type 2 diabetes mellitus.

Methods: We studied 522 patients with newly diagnosed type 2 diabetes mellitus who were participants in the Early Activity in Diabetes (Early ACTID) study. Patients completed a 7-day sleep diary and sleep questionnaire. Information from these was derived for average sleep duration (minutes), average nap duration (minutes) and average number of night-time awakenings. Body mass index (BMI) was calculated from objective measurements of height (cm) and weight (kg). Insulin resistance was obtained using the HOMA-IR standardized technique.

Results: Average number of night-time awakenings was positively and significantly correlated with BMI (r = 0.21, p < 0.001) and insulin resistance (r = 0.11, p = 0.041). Our pathway analysis model demonstrated that nap duration and night-time awakenings, both indicators of sleep quality, were directly associated with BMI and indirectly associated with insulin resistance, whilst considering BMI as a potential mediator (p = 0.05).

Conclusion: Sleep quality, not sleep duration, plays an important role in insulin resistance in those with newly diagnosed type 2 diabetes mellitus. BMI may mediate the relationship between indicators of sleep quality and insulin resistance. There is a need to examine the impact of improving sleep quality in patients with type 2 diabetes, on obesity and insulin resistance.

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0722

STATUS OF ASSOCIATED FACTORS FOR THE QUALITY OF SLEEP IN PATIENTS WITH DIABETES MELLITUS: AN EPIDEMIOLOGICAL ASSESSMENT

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Introduction: Diabetes is a chronic disease of abnormal blood sugar concentration, often accompanied by a variety of complications. It has a broad impact on the patient's quality of life. Sleep quality is closely related to the incidence and severity of type 2 diabetes mellitus. Our aim is to understand the association between quality of sleep and the prevalence of type 2 diabetes mellitus.

Methods: The cross-sectional study has conducted 860 participants (68 with type 2 diabetes mellitus, 792 non-type 2 diabetes mellitus) from the sleep center of Chang Bing Show Chwan Memorial Hospital. Using structured questionnaire containing demographic variables, Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and Athens Insomnia Scale (AIS) were to evaluate the quality of sleep. The diabetes screening standard is according to World Health Organization (WHO) in 2006 (fasting plasma glucose ≥ 126 mg/dL, or 2 hours postprandial plasma glucose ≥ 200 mg/dL, or glycated hemoglobin (hemoglobin A1c $\geq 6.5\%$), hyperglycemia crisis and random glucose ≥ 200 mg/dL). Odds ratio (ORs) were to evaluate the relative factors associated with the prevalence of type 2 diabetes mellitus. Data analysis used SPSS 20.0 with chi-square test, one-way ANOVA and logistic regression to analyze statistics.

Results: According to our results, patients with type 2 diabetes mellitus have significantly higher than comparison group in body mass index (BMI) (mean [M] \pm standard deviation [SD] = 27.74 ± 3.96 vs. 26.42 ± 4.80 , $p = 0.028$), SBP (M \pm SD = 136.42 ± 19.58 vs. 126.44 ± 18.25 , $p < 0.001$), but not significantly in DBP, NC, PSQI score ($p = 0.194$, 0.274 , 0.632 , respectively). Multiple logistic regression analysis showed PSQI score ≥ 5 (vs. < 5) has higher risk of type 2 diabetes mellitus, the OR = 1.14 (95% confidence interval = $0.51-2.55$) after adjusted for age, gender, BMI, blood pressure.

Conclusion: There is a weak positive association between PSQI score and type 2 diabetes mellitus, although there is no significance statistically. The epidemiologic link between sleep problems and diabetes is still unclear. More subjective assessment tools, such as polysomnography (PSG) and actigraphy, and more patient numbers will be needed to analyze the relationship between sleep problems and type 2 diabetes mellitus in the future.

0723

PREDICTORS OF OSA RISK IN BLACKS WITH METABOLIC SYNDROME

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Introduction: Identification of risk factors for obstructive sleep apnea (OSA) is important to enable comprehensive intervention to reduce associated cardiovascular (CV) morbidity and mortality. The Metabolic Syndrome Outcome Study provides a unique opportunity to assess the presence of these factors among blacks, a group that is at high risk for adverse CV outcomes. The purpose of this study was to investigate risk of OSA among blacks with metabolic syndrome

Methods: The present study utilized data from the Metabolic Syndrome Outcome (MetSO) study, an NIH-funded cohort study of blacks with metabolic syndrome. A total of 1,035 patients provided data for the present analysis. Patients were diagnosed with metabolic syndrome using criteria articulated in the joint interim statement for harmonizing the metabolic syndrome. OSA risks for all patients were assessed with the Apnea Risk Evaluation System (ARESTM). Those with an ARES score ≥ 6 were considered at high OSA, based on previous validation studies. Data was coded and analyzed by an experienced statistician using SPSS 19.0.

Results: The average age of the sample was 62 ± 14 years (range: 20-97); 71% were female. Of the sample, 93% were diagnosed with hypertension; 61%, diabetes; 72%, dyslipidemia; 90% were overweight/obese; 33% had a history of heart disease and 10% had a stroke. ARES data indicated that 48% were at high OSA risk. Using multivariate logistic regression analysis, adjusting for age and gender, we observed that obesity was the strongest predictor of OSA risk (OR = 1.59 , 95%CI = $1.24-2.04$, $p < 0.0001$). This finding remained significant even after adjustment for blood pressure, LDL, HDL, and glucose levels (OR = 1.44 , 95%CI = $1.11-1.86$, $p < 0.001$).

Conclusion: Of all of the markers of the metabolic syndrome, obesity is the most important predictor of increased risk of OSA among blacks. Our finding is consistent with previous research regarding the obesity-apnea link.

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0724

SUBSCAPULAR SKIN FOLD THICKNESS AND SYSTEMIC INFLAMMATION IN OSA PATIENTS: AN USEFUL BEDSIDE CLINICAL TOOL?

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Introduction: OSA is characterized by nocturnal episodes of intermittent hypoxia (CIH). As CIH is thought to represent the pathophysiologic inflammatory basis of atherosclerosis in these patients and skin fold thickness correlates with several inflammatory markers in non-OSA patients, including IL-6 and CRP, we aimed to assess if any of the SFA measurements could be particularly identified as correlates of OSA, CIH severity and magnitude of the inflammatory response in these patients.

Methods: Demographics, medical and social history, blood pressure and peripheral blood count were obtained from the Computerized Patient Record System for a total of 14 male adults recruited consecutively

from those referred to the Sleep Clinic at the Salem Veterans Affairs Medical Center (VAMC) and subsequently diagnosed with OSA after a PSG at the same institution between May 2006 and September 2008. Adults with previous diagnostic or therapeutic PSG, diabetes, chronic lung or thyroid disease, cardiac failure, eating disorders, oxygen or glucocorticoid therapy were excluded. SFA measurements (biceps, triceps, subscapular and suprailiac skinfold thickness) were taken the night of the PSG and serum leptin, adiponectin and hs-CRP were measured fasting the morning after PSG.

Results: Age, BMI, leptin, adiponectin, hs-CRP, peripheral WBC, AHI and lowest and mean O₂ sat, were as follows (mean \pm SEM): 56.4 \pm 2.74 years; 33.8 \pm 1.35; 18.4 \pm 3.02 ng/ml; 11.9 \pm 4.9 ng/ml; 6.7 \pm 2.5 mg/L; 23.3 \pm 7.9; 76 \pm 2.8% and 90 \pm 1.2%, respectively. Independent of age, BMI, smoking history and AHI, the subscapular skinfold thickness correlated with the serum hs-CRP ($p = 0.03$, $r = 0.75$), lowest O₂ sat ($p = 0.01$, $r = -0.8$) and atrial fibrillation history ($p = 0.03$, $r = 0.75$).

Conclusion: Subscapular skin fold thickness in OSA could potentially evolve into a useful clinical tool aimed at identifying patients with intermittent hypoxia-induced systemic inflammation and therefore possible higher future risk of CVD in these patients.

0725

ASSOCIATIONS BETWEEN UNCONTROLLED BLOOD PRESSURE AND OBSTRUCTIVE SLEEP APNEA AMONG BLACKS WITH METABOLIC SYNDROME

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Introduction: Many risk factors have been implicated in the pathophysiology of obstructive sleep apnea (OSA). Recent evidence suggests that medical risk factors, such as uncontrolled/high blood pressure (BP), high cholesterol, triglycerides, high body mass index, diabetes, and dyslipidemia (all indicators of metabolic syndrome) are highly comorbid with OSA. However, data on the relationships between these risk factors and OSA among blacks with metabolic syndrome are lacking.

Methods: Data for the present study were collected from 340 participants from the Metabolic Syndrome Outcome (MetSO) study, a NIH-funded cohort study of 1,035 blacks with metabolic syndrome (mean age = 62 \pm 13 years, 69% female, and 43% with annual family income < \$10K). During initial interviews, patients provided sociodemographic, health risks, and history of chronic diseases. Patients with a score ≥ 6 on the Apnea Risk Evaluation System (ARESTTM) were considered at high OSA risk. Logistic regression analyses were employed to investigate whether metabolic syndrome indicators, particularly uncontrolled blood pressure, increased the odds of OSA.

Results: Of the sample, 77.1% was at risk for OSA and 16.8% had uncontrolled BP. Analysis also showed 60.4% were diabetic, 8.9% had a stroke history, 74.3% had dyslipidemia, 91.1% were either overweight or obese and 30.9% had heart disease. Mean systolic BP was 134.8 \pm 18.4; diastolic BP was 75.6 \pm 11.9; LDL cholesterol was 105.6 \pm 36.9; HDL cholesterol was 48.0 \pm 17.3; triglycerides was 135.8 \pm 81.2; glucose was 138.4 \pm 68.3; and HbA1c was 7.93 \pm 1.63. Logistic regression analysis showed that uncontrolled BP independently increased the odds of OSA risk (OR = 1.94, 95% CI = 1.12-3.32, $p < 0.01$).

Conclusion: Our findings suggest that uncontrolled BP was associated with a twofold greater risk of OSA in blacks. The clinical implication of this finding is that blacks with metabolic syndrome and who have uncontrolled BP should be screened for the presence of OSA.

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0726

HEMODYNAMIC FINDINGS IN PATIENTS WITH PULMONARY ARTERIAL HYPERTENSION AND CONCOMITANT OBSTRUCTIVE SLEEP APNEA

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Introduction: The prevalence of pulmonary hypertension (PH) in patients with obstructive sleep apnea (OSA) has been looked in many studies. However, the prevalence of OSA in patients with PAH and its hemodynamic effects are not well understood. Recent data suggests that treatment of OSA may reduce pulmonary pressures, which can be particularly critical in advanced W.H.O. Group 1 pulmonary arterial hypertension (PAH) patients. However, data is limited as to which patients should be tested with polysomnogram and how concomitant OSA affects pulmonary hemodynamics in PAH.

Methods: We studied hemodynamic data in patients with right heart catheterization (RHC) confirmed PAH with and without obstructive sleep apnea who were on pulmonary vasodilators. Charts on all patients with PAH diagnosed between January 2008 and December 2012 were reviewed retrospectively. Data on demographics, polysomnography, RHC, comorbidities and medications were analyzed.

Results: Records on 53 patients with PAH were available to collect data. Polysomnographic studies were available on 14/55 (25%) patients. Sleep apnea was diagnosed in 8/14 providing an estimate prevalence of sleep apnea in PAH patients of 15% (8/53). Compared to sleep apnea (SA) vs no-sleep apnea (NSA) group, median apnea-hypopnea index (AHI) was 10.1 ($r = 5.6-36.2$) vs 1.95 ($r = 0.2-4.8$), mean age was 62 vs 55, males were 50% vs 16%, BMI was 32.2 vs 27.1, nocturnal desaturation ($> 10\%$ of time spent $< 80\%$ oxygen saturation) present in 75% vs 33%, periodic limb movement disorder was present in 50% vs 33%, comorbidities including diabetes, COPD and CHF were present in 25% vs 33%, 50% vs 0% and 62% vs 33% respectively. RHC data showed mean pulmonary artery pressure of 37 vs 53.5 mmHg, pulmonary capillary wedge pressure of 15 vs 8 mmHg, trans-pulmonary gradient of 23 vs 44.5 mmHg, trans-diastolic gradient of 5.5 vs 23.5 in the SA vs NSA group.

Conclusion: Sleep apnea is not uncommon in patients with PAH. PAH patients with sleep apnea tend to have lower mean pulmonary artery pressure and higher pulmonary capillary wedge pressure. Trans-pulmonary pressure and trans-diastolic pressure were also lower in PAH patients with OSA compared to ones without sleep apnea.

0727

EFFECTS OF OSA SEVERITY ON DIABETIC PERIPHERAL NEUROPATHY IN OBESE ADULTS

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Introduction: A direct, dose-response relationship between obstructive sleep apnea (OSA) and diabetic peripheral neuropathy (DPN) has been demonstrated previously. We compared DPN symptoms to OSA severity (AHI, oxygen-desaturation index [ODI]) at baseline, 1, 2, and 4 years after a weight loss intervention in obese, diabetic participants.

Methods: Analyses included 307 participants (age 61.4 \pm 6.5 years, BMI 36.3 \pm 5.6 kg/m², 59.6% female) enrolled in the Sleep AHEAD

cohort of the Look AHEAD study, which investigated long-term health impacts of intensive lifestyle intervention versus diabetes support and education. Polysomnography, Michigan Neuropathy Screening Instrument (MNSI), and Epworth Sleepiness Scale (ESS) data were obtained at baseline, 1, 2, and 4 years. Baseline MNSI score was evaluated as both a categorical (MNSI ≥ 4 or MNSI < 4) and continuous measure to assess the relationship between DPN and OSA severity. Associations at baseline were assessed using logistic or negative binomial regression. Longitudinal mixed effects models were used to assess the relationship between OSA severity and MNSI changes over time.

Results: Baseline data revealed no association between OSA severity and MNSI after adjusting for BMI, whether using MNSI as a categorical or continuous variable. However, there was a significant relationship between subjective sleepiness and both categorical (OR [95% CI] = 1.09 [1.03, 1.16]; $p = 0.006$) and continuous (β [95%CI] = 0.04 [0.01, 0.06], $p = 0.005$) MNSI; higher ESS was associated with higher MNSI scores. In examining the change in MNSI over time, we found a relationship between more severe OSA and faster increase in MNSI. After adjustment for BMI and intervention group, ODI showed the strongest association ($p = 0.022$); there was a similar, but non-significant trend seen for AHI ($p = 0.120$).

Conclusion: At baseline, subjective sleepiness, but not OSA severity, was associated with MNSI score in obese, adult diabetics. In longitudinal data, we observed a relationship between more severe OSA and faster increases in MNSI score.

0728

ASSOCIATION OF SLEEP DISORDERED BREATHING WITH NOCTURNAL CARDIAC ARRHYTHMIAS: THE DETERMINING RISK OF VASCULAR EVENTS BY APNEA MONITORING (DREAM) STUDY

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Introduction: Sleep-disordered breathing (SDB) is associated with recurrent physiologic stresses (e.g., hypoxia, hyperadrenergic activity) that may predispose to arrhythmias. Among a cohort of U.S. veterans, we examined whether SDB was associated with nocturnal cardiac arrhythmias.

Methods: 1522 U.S. veterans underwent polysomnography (PSG) for suspected SDB and had EKG analyzed for arrhythmia (Somte; Victoria, Australia). Demographic, health, medication and PSG information were collected. The apnea hypopnea index (AHI) was the main explanatory variable, categorized according to severity: AHI < 5 ; AHI = 5-15; AHI > 15 . Outcomes included ventricular arrhythmias, supraventricular arrhythmias, and conduction delay. We used logistic regression to determine if AHI was associated with cardiac arrhythmias after adjusting for age, BMI, gender, CVD disease (stable angina, coronary artery disease, myocardial infarction, congestive heart failure, cerebrovascular disease, pace maker, CABG/angioplasty). We used chi-squared test for linear trend to examine a dose-response relationship between SDB severity and risk of cardiac arrhythmia.

Results: There was a dose-response relationship with SDB severity such that in those with AHI < 5 , AHI = 5-15 and AHI > 15 , the frequency of complex ventricular ectopy (bigeminy or trigeminy or quadrigeminy or nonsustained ventricular tachycardia) was 10%, 19.8% and 27.1% ($P < 0.0001$); atrial fibrillation was 10%, 19.8% and 27.1% ($P < 0.006$), and intraventricular conduction delay was 10%, 19.8% and 27.1% respectively ($P < 0.0001$). After adjusting for multiple confounders, the odds of having complex ventricular ectopy was 2.46 (95% CI 1.73-3.49,

$p < 0.0001$), 4.12 (95% CI 1.16-14.60, $p = 0.028$) in atrial fibrillation, and 3.77 (95% CI 2.38-5.96, $p < 0.0001$) in intraventricular conduction delay in subjects with compared to those without SDB.

Conclusion: Nocturnal cardiac arrhythmia was associated with SDB after adjusting for confounding cardiovascular risk factors. There is a dose-response relationship between severity of SDB and the risk of having nocturnal cardiac arrhythmias.

0729

OBSTRUCTIVE SLEEP APNEA (OSA) AND AUTOIMMUNE DISORDERS

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Introduction: 15% of adults exhibit OSA in general population, majority of which remain undiagnosed. OSA has been associated with chronic inflammation and heart disease; however, no direct pathway is explained. Autoimmune disorders due to OSA may be such possibilities and the purpose of this study is to investigate such paradigms in clinical setting.

Methods: This is retrospective analysis of 400 patients in private practice clinic at San Angelo, Texas. OSA being an outcome was diagnosed by sleep specialist. Socio-demographic, laboratory and clinical information were obtained from medical records. Logistic models were employed to determine association between risk factors and OSA.

Results: One third (31%) of patient population suffered from OSA. More than half (51%) were aged (age > 65), 56% female and three-fourths were white. Among those with OSA, 86% were obese, 81% were asthmatic, 17% were hypertensive, 29% had a lung perfusion (1.200) while only 4% patients without OSA suffered from lupus. Univariate analysis exhibited associated OSA with low DLCO and those with diabetes or hypertension have twice odds of developing OSA ($p = 0.003$, $p = 0.014$) compared to control group. Multivariate logistic regression after controlling for age, gender ethnicity depicted that one-unit increase in BMI result in 9% increase in odds of OSA ($P = 0.000$). B2IgA exhibit significant relationship with outcome ($P = 0.017$). Patients with lupus were 4 times more likely to suffer OSA ($P = 0.007$).

Conclusion: Understanding the role of OSA in onset of autoimmune disorder is vital and will further help us in unraveling the association of OSA with chronic diseases. We hope that this finding will spur further research in this direction and advance policies to improve early detection, prevention, and control of OSA in co-morbid patients.

0730

VARIATION OF SERUM 25-HYDROXYVITAMIN D LEVELS WITH SLEEP DURATION AND CONTINUITY ACROSS ETHNIC GROUPS: MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS

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Introduction: Low serum 25-hydroxyvitamin D (25[OH]D) is highly prevalent and early research suggests an association between low 25(OH)D and daytime sleepiness. Vitamin D receptors are found in brain regions involved in sleep regulation and inflammatory signaling. There are limited data regarding the relationship between 25(OH)D and sleep duration, continuity, and symptoms. Elucidating variation in the associations between 25(OH)D levels and sleep across ethnic groups is especially important given known ethnic differences in these traits.

Methods: We conducted a cross-sectional study within the Multi-Ethnic Study of Atherosclerosis (MESA). Sleep outcomes were measured by overnight polysomnography, 7-day actigraphy, and sleep questionnaires during the MESA Sleep Ancillary study 2010-2013 in 1707 study participants. We considered annualized serum 25(OH)D at clinical values (< 20 , 20 - 29 , and ≥ 30 ng/mL), race-specific quintiles, and continuous values from samples collected at MESA exam 1. We employed multivariate linear regression to determine the association between 25(OH)D levels with sleep duration, efficiency, and symptoms, and explored ethnic variation in race interaction models.

Results: Mean age was 68.2 ± 9.1 years, 45.2% male, and 37.6% white, 27.6% African American, 11.8% Chinese, and 23.1% Hispanic. Mean annualized serum 25(OH)D was 25.4 ± 10.7 ng/mL and 34.6% were 25(OH)D deficient (< 20 ng/mL). Participants deficient in 25(OH)D had the shortest sleep duration, lowest sleep efficiency, and highest Epworth scores. Overall, these associations were attenuated and became non-significant after adjustment. Though we did not find an interaction by race, in African Americans, adjusted average sleep duration was 26.1 ± 11.1 minutes shorter in 25(OH)D deficient than in 25(OH)D sufficient individuals ($p = 0.04$).

Conclusion: In this large multiethnic cohort, variation in the relationship between 25(OH)D and sleep outcomes were largely explained by confounding factors. However, in African Americans, an association between shorter sleep duration and low 25(OH)D was identified, suggesting low 25(OH)D levels may influence sleep duration in this vulnerable population.

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0731

HYPERTHYROIDISM ASSOCIATED WITH INCREASED NON-RESPIRATORY RELATED AROUSALS FROM SLEEP

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Introduction: Thyroid disorders with well-established associations to OSA and insomnia. Graves' disease associated with complaints of fatigue and sleep fragmentation, sleepiness not commonly associated. Objective polysomnogram measures of sleep and sleep quality were explored in active Graves' disease to develop characteristics of excessive sleepiness.

Methods: Five consecutive active Graves' disease patients from military endocrine practice with elevated Epworth Sleepiness Score (ESS), and fitful sleep given in-lab overnight sleep study (PSG), performing civilian sleep center unaware of this endeavor.

Results: 5 patients included (100% female, 24.4 years ± 5.5 , BMI 25.5 kg/m² ± 5.0). Somnolence common (ESS 15.45 ± 1.81). Sleep stages normal. One of 5 patients went to PSG 2 years after successful treatment for Graves' disease: at PSG BMI 21.1 kg/m², ESS $6/24$ (18/24 at presentation), TSH 0.198 , AHI 1.3 , Arousal Index 12.5 /hour. Remaining 4 patients receiving PSG within two weeks of laboratory confirmation of hyperthyroidism broke out into two groups: Group 1. BMI 22.55 kg/m² ± 0.35 ; TSH < 0.01 (0.34 - 4.82 mIU/liter); fT4 3.66 ± 1.47 (0.6 - 1.35 ng/dcilitr); fT3 18.65 ± 7.00 (2.0 - 4.4 pg/ml); thyroid stimulating immunoglobulin (TSI) $266.5\% \pm 88.38$ ($< 110\%$); radioactive iodine scan and uptake (RAIU) @ 24 hours, homogenous $73.5\% \pm 14.85$ ($< 30\%$). Group 2. BMI 30.72 kg/m² ± 3.35 ; TSH 0.005 ± 0.01 ; fT4 0.99 ng/dl ± 0.09 ; fT3 3.5 ± 0.7 ; TSI $118\% \pm 31.1$; RAIU @ 24 hours, homogenous $36\% \pm 15.6$. Groups 1 & 2 with elevated arousal index (27.75 ± 13.2), but normal AHI 2.4 (range 0 - 6.8) and normal PLMSI (1.0 ± 0.5 events/hour).

Conclusion: Excessive daytime sleepiness was common (high ESS) in active Graves', and associated with increased nonrespiratory-related arousals—likely related to the hypermetabolic state.

0732

DIFFERENTIAL PREDICTORS OF OVERWEIGHT/OBESITY: SLEEP TIMING VS. INSUFFICIENT SLEEP

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Introduction: Studies have shown that decreased sleep duration and later sleep timing (midpoint of sleep) are associated with an increased body mass index (BMI). However, previous research has not determined which of these two sleep parameters is a better predictor of BMI. This study sought to determine whether sleep timing is a better predictor of the likelihood of being overweight/obese than insufficient sleep.

Methods: Volunteers consisted of 459 postmenopausal women (mean age = 67.71 ± 7.87 years) participating in the Women's Health Initiative study. Of the sample, 72% were non-Hispanic white; 14% Hispanic; 9% black; and 5% other. Volunteers wore an actigraph (ActiLume) (ACT) and kept a seven-day sleep diary (SD) to estimate habitual sleep durations. ACT data were scored using a validated algorithm (Cole-Kripke) provided by the ActiLume manufacturer. Subjective and actigraphic data were averaged over a period of 7 days to obtain an index of both objective and subjective sleep duration. Sleep timing was derived by calculating the midpoint of reported bedtimes and rise times.

Results: Analysis revealed that 20.6% of the volunteers experienced short sleep (< 6 hours) based on subjective data; 47.7% experienced short sleep based on actigraphic estimates. The average sleep timing occurred at 03:08. Of the sample, 62% were categorized as overweight or obese. Multivariate-adjusted linear regression showed that only ACT-derived sleep duration was significantly associated with being overweight/obese (OR = 2.46 (95% CI: 1.39-4.35, $p < .001$). There were no statistically significant associations between subjective sleep duration or sleep timing with overweight/obesity. The model adjusted for age, race, physical activity and sleep medications.

Conclusion: Results suggest that insufficient sleep as measured by actigraphy is the single most important predictor of the likelihood of being overweight/obese among older women. Unlike previous research, sleep timing was not significantly associated with being overweight/obese. Future studies should explore whether similar observations are made for men.

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0733

ENERGY METABOLISM GENE POLYMORPHISMS ARE ASSOCIATED WITH SLEEP DURATION AND MAINTENANCE AMONG ADULTS WITH HIV/AIDS

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Introduction: Energy metabolism genes have been associated with sleep outcomes in prior animal and human research. The purpose of this study was to determine whether polymorphisms in energy metabolism genes are associated with objectively measured sleep parameters in adults living with HIV/AIDS.

Methods: A convenience sample of 289 adults (193 men, 73 women, and 23 transgender) with HIV/AIDS was recruited from HIV clinics and community sites in the San Francisco Bay Area. A wrist actigraph was worn for 72 hours to estimate total sleep time (TST) and the percentage

of wake after sleep onset (WASO%). Genotyping was conducted for 11 candidate genes involved in sleep-wake cycles and energy metabolism: circadian locomotor output cycles kaput (CLOCK), period (PER1, PER2, PER3), cryptochrome (CRY1), adiponectin (ADIPOQ), ghrelin (GHR1), leptin (LEP), lamin A/C (LMNA), peroxisome proliferator-activated receptor alpha (PPARA) and gamma (PPARG).

Results: TST ranged from 78 to 684 minutes (mean 371 + 99 SD), and WASO% ranged from 0.6% to 78.9% (mean 20.8% + 14.8% SD). The correlation between TST and WASO% was $r = .720$. TST and WASO% did not differ by gender and were not associated with age (range 22-77 years). Controlling for potentially confounding variables (race, gender, CD4+ T-cell count, waist circumference, medication use), TST and WASO% were both associated with ADIPOQ rs182052 and PPARG rs709151 polymorphisms. In addition, TST was also associated with GHR1 rs26802 and PPARA rs135551, rs135547, and rs4253655.

Conclusion: In this chronic illness population, polymorphisms in several metabolic genes were associated with WASO and TST. These findings strengthen the evidence for an association between the genetics of energy metabolism and sleep disturbance. There was no evidence for associations between sleep disturbance and CLOCK or PER gene candidate SNPs. These results provide direction for future intervention research related to metabolic mechanisms.

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0734

NEURO-SONO SCALE (NSS) SCREENS ASTHMATIC PATIENTS AT RISK FOR OSAS

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Introduction: Neuro-Sono Scale (NSS) predicts the chance of OSAS according to the variables: high blood pressure (HBP), snoring, vascular disease, body mass index (BMI), age and neck circumference (NC). Although asthma and OSAS are quite prevalent many asthmatic patients attribute eventual daytime symptoms only to asthma, and both physicians and patients may not be aware of the simultaneity of these diseases. We aim to determine whether the NSS is useful in risk stratification of patients with asthma and OSAS.

Methods: We applied the NSS in 24 patients with moderate to severe asthma at the emergency room of the Hospital São Paulo, Escola Paulista de Medicina, Universidade Federal de São Paulo. The final NSS score depends on the presence of HBP (1.59 points), snoring (0.52), vascular disease (0.27), BMI 25-30 kg/m² (0.46), BMI > 30 kg/m² (0.92), age of 26-45 (1.57), age of 46-65 (3.14), age > 65 (4.71), NC 35-38 cm (0.55), NC 30-42 cm (1.1), NC 43-46 cm (1.65), NC > 46 cm (2.2 points). The final score is zero in the absence of HBP, snoring, vascular disease, BMI < 25, age < 25 and NC < 35 cm. A final score above 3 suggests the presence of OSAS. All patients underwent polysomnography. We used the Fisher exact test for statistical analysis.

Results: Mean age and BMC were respectively 40.21 ± 15.26 years, and 28.61 ± 7.44 kg/m². Twelve patients had OSAS and 10 (83%) scored above 3 on the NSS ($p < 0.05$).

Conclusion: NSS proved to be useful in stratifying asthmatic patients in risk for OSAS. It is a simple and easy of application tool, that uses routine data from patients. Because patients with moderate or severe asthma may experience daytime symptoms similar to patients with OSAS, some scales like the Berlin can be less useful than NSS.

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0735

ASTHMATIC PATIENTS SHOW ABNORMAL STANFORD SLEEPINESS SCALE SCORE IN THE EMERGENCY ROOM.

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Introduction: Asthmatic patients have difficulty maintaining sleep due to breathing difficulty or nocturnal cough. The emergency physician usually does not evaluate the degree of sleepiness in these patients, and there are no studies evaluating this population when they seek care in the asthmatic acute phase.

Methods: We applied the Stanford Sleepiness Scale (SSS) in 56 patients treated at the Emergency Room of the São Paulo Hospital, Escola Paulista de Medicina, Federal University of São Paulo. Patients had moderate or severe asthma. SSS was applied one hour after the initial measures recommended by the Global Initiative for Asthma (GINA). Patients returned for reassessment of SSS and respiratory functions. SSS was applied to patients seen in the emergency room during the morning and afternoon. We did not include patients seen at night. The SSS scores range from 1 to 8 (fully alert to sleeping). Data were analyzed through the Mann-Whitney test.

Results: Median SSS in 56 patients in admission was 3, and 7 had a score of 6. Thirty six patients returned 7 days later for reevaluation and presented a median SSS of 1, and only 3 scored 6. There was statistically significant reduction in SSS ($p = 0.0007$) after acute asthma crises treatment.

Conclusion: Patients with moderate/severe asthma scored higher on the SSS during their stay in the emergency room, whose score decreased one week after treatment of the acute phase and treatment reorientation. We did not investigate the reasons for these findings yet, but it can be associated to poor sleep at night (or nights) before emergency room visit, or inflammatory mechanisms of asthma itself, or association with obstructive sleep apnea, were responsible for drowsiness. It should be noted that high SSS scores occurred while patients were on beta agonist and corticosteroid, drugs with a potential stimulating effect.

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0736

A COMPARISON OF SLEEP, QUALITY OF LIFE AND FATIGUE IN GULF WAR ILLNESS AND CHRONIC FATIGUE SYNDROME

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Introduction: Similarities have been identified between individuals diagnosed with Chronic Fatigue Syndrome (CFS) and Gulf War Illness (GWI). Among these are fatigue and non-restorative sleep. However, there has been no attempt to compare self-reported sleep in these populations. A better understanding of sleep characteristics and their relationships to other psychosocial variables in these groups may shed light on potential sleep interventions.

Methods: Sixty-two participants (37 GWI, 25 CFS) completed self-report questionnaires including sleep diaries, the SF-36 (health-related quality of life) and the Multidimensional Fatigue Inventory (MFI).

Results: Mean times in bed (TIB; hours) for CFS and GWI were 8.6 and 7.9, respectively ($p = .08$). Mean total sleep time (TST) was 7.3 for CFS and 6.2 for GWI ($p = .003$); sleep efficiency was 84.1 and 80.2 for CFS and GWI, respectively (n.s.). Correlations between TIB, TST, SF-36

and MFI were computed for both groups. There were no significant correlations between TST, SF-36 and MFI scores. Significant correlations between TIB and several SF-36 scales were noted for the CFS (Physical Function $r = -.51$, Role-Emotional $r = -.38$) and the GWI group (Physical Function $r = -.38$, Role-Physical $r = -.35$, Role-Emotional $r = -.42$, Social Functioning $r = -.38$, Bodily Pain $r = -.37$).

Conclusion: We show that GWI patients report shorter TST than CFS patients. However, no relationship between TST and quality of life and fatigue parameters were found for either group. Relationships between TIB and quality of life and fatigue scales were identified for both groups, suggesting that greater daytime impairment is consistent with greater TIB, but not with TST. With less than optimal sleep efficiencies (both $< 85\%$) it may be reasonable to reduce TIB as part of a behavioral approach to improving non-restorative sleep. However given associations between TIB and self-reported daytime dysfunction, adaptations to traditional TIB restrictions may need to be considered.

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0737

SLEEP DISORDERS MASK PERIPHERAL MARKERS OF INFLAMMATION AND IMMUNE SYSTEM ACTIVITY IN CHRONIC FATIGUE SYNDROME

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Introduction: Chronic fatigue syndrome (CFS) is a clinical diagnosis based upon the presence of persistent and unremitting fatigue accompanied by well-established case-defining symptoms. No diagnostic laboratory abnormalities or clinical tests appear to correlate with the defining symptoms. Clinical interventions produce inconsistent results with variability in treatment outcomes attributed to “unidentified moderating variables.” We took the opportunity to explore for those potential moderating variables within archived sleep studies and plasma/serum samples collected during a population-based study of CFS, conducted by the Centers for Disease Control and Prevention.

Methods: We re-analyzed polysomnography records and performed new analyses of serum/plasma samples. Using a database repository of curated biological interactions and functional annotations, we developed biological regulatory networks associated with case-defining symptoms of fatigue and unrefreshing sleep. As a cytokine regulatory network was linked with the symptom of fatigue, we employed multiplexed electrochemiluminescence to measure candidate cytokines and analytes within serum and plasma samples.

Results: Sleep and biochemical measures were compared between CFS ($n = 39$) and non-fatigued (NF) controls ($n = 39$). A sleep disorder was identified within 58% of CFS participants. Initial biochemical comparisons yielded no between group differences. We then sub classified CFS participants by the presence or absence of a sleep disorder. Significantly increased IL8 (452.9 ± 103 vs 199.7 ± 62.9 pg/ml) and lower insulin-like growth factor binding protein (IGBF) levels (3282.5 ± 591.2 vs 7987.5 ± 1.84 pg/ml) emerged from CFS without a sleep disorder ($n = 23$).

Conclusion: We suspect that a high prevalence of comorbid sleep disorders masks markers of inflammation and immune system activation in many CFS patients. Such confounding disorders and biochemical perturbations may be among the “unidentified moderating variables” that impact treatment outcomes in cohort studies.

Support (If Any): Centers for Disease Control and Prevention.

0738

THE RELATIONSHIP BETWEEN SEXUAL FUNCTION AND QUALITY OF SLEEP IN CAREGIVING MOTHERS OF SONS WITH DUCHENNE MUSCULAR DYSTROPHY

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Introduction: The task of the caregiver, especially a caregiving mother of a son with a chronic and fatal disease, may interfere with the quality of sleep, sexuality and some hormone levels.

Methods: All mothers were evaluated with the application of the questionnaire of Female Sexual Function Index (FSFI) and the Pittsburgh questionnaire (PSQI). Besides, the serum levels of testosterone, estradiol, follicle-stimulating hormone, luteinizing hormone, progesterone, adrenocorticotrophic hormone and cortisol, were determined. We evaluated 20 caregiving mothers of sons with Duchenne Muscular Dystrophy (DMD) and 20 caregiving mothers of sons without any neuromuscular or chronic disease. All of them, voluntarily responded the evaluating questionnaires about their sexuality and their quality of sleep, as well as contributed with blood samples to evaluate their hormonal levels.

Results: By means of the FSFI questionnaire, we have observed that the caregiving mothers of sons with DMD showed sexual dysfunction and anorgasmia. The PSQI demonstrated that these caregiving mothers present bigger sleep latency, reduction of sleep efficiency, daytime dysfunction and poor quality of sleep. The hormonal levels demonstrated a rise in cortisol levels, which was correlated with the compromised sexuality and quality of sleep.

Conclusion: This study indicates that caregiving mothers of sons with DMD show major sexual dysfunction and a reduction in their quality of sleep.

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0739

POTENTIAL THEORETICAL UNDERPINNINGS OF INSOMNIA SYMPTOMS OF PARENTS AND THEIR CHILDREN WITH ASD

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Introduction: Of the approximately 1 in 88 children diagnosed with autism spectrum disorder (ASD), insomnia symptoms are the most frequently reported sleep complaint. Parents of children with ASD also report insomnia symptoms; however, the bases for these parent and child symptoms have yet to be determined.

Methods: A systematic review and analysis was implemented to consider potential underpinnings of insomnia as catalysts for theory-driven sleep research among families of children with ASD. Search engines included Cochrane, PubMed, Psych Info and CINAHL. Key terms included autism spectrum disorders, insomnia, phenotypes, hyper-reactivity, and hyper-arousal.

Results: The systematic review yielded 30 articles that provided information on key search terms. Sleep onset and maintenance were the most reported insomnia symptoms among children with ASD; abnormal processing in the attentional network that affect the child's ability to disengage from stimuli and self-regulate at bedtime, or when waking dur-

ing the night was a potential explanation. Two phenotypes of insomnia were hypothesized, one associated with physiologic hyper-arousal, the other with cognitive-emotional and cortical arousal that could account for insomnia symptoms among parents of children with ASD. Studies of melatonin among children with ASD found that 1) plasma melatonin levels were lower in children with ASD than in typical children, and 2) children with ASD compared to normal controls demonstrated abnormally low nighttime levels of 6-sulphatoxymelatonin, a melatonin metabolite. Another study also reported abnormal melatonin levels in the unaffected parents of children with ASD.

Conclusion: Although child sleep patterns can significantly influence parental sleep, findings from this systematic review may be extrapolated to suggest several salient theoretical/ conceptual foundations for future insomnia research and interventions, including a genetic predisposition and/or disrupted melatonin release for insomnia symptoms that may be shared by some parents and their children with ASD.

0740

INSOMNIA AND CHARLSON COMORBIDITY: LOOKING BEYOND THE INDEX

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Introduction: While some authors report insomnia findings adjusted for the Charlson Comorbidity Index, a strong predictor of mortality, few have actually focused on the quantitative association of insomnia with this index, nor have they determined the specific components most strongly associated with insomnia.

Methods: From a sample of 7200 randomly selected veteran patients who visited a primary care facility at JAHVA medical center between 2000 and 2012, we selected all available insomnia patients (ICD-9 = 307.42 or 780.52; n = 772) and 3088 controls matched 4:1 by year of first insomnia diagnosis. The Charlson/Deyo index had 47 components, each reflecting multiple ICD codes. Logistic models adjusted for age, gender, race, and BMI were used to determine the association of the overall Charlson index and each component with insomnia.

Results: The odds ratio (OR) of insomnia for each unit increase in the Charlson index was 1.07 (p < 0.05). Categorization of the index revealed that subjects in the most severe category (≥ 7) had double the odds of insomnia compared to subjects in the least severe category (≤ 2) (p < 0.001), but no excess risk was seen in the middle category. Eight index components were found to be significantly (p < 0.05 or lower) associated with insomnia: hypertensive heart disease (OR = 1.49); bronchitis (OR = 1.48); pulmonary heart disease (OR = 2.15); liver cirrhosis (OR = 1.63); liver abscess (OR = 2.93); liver, gallbladder, or pancreatic malignant neoplasms (OR = 5.88); secondary malignant neoplasms of the lymph nodes, respiratory, or digestive systems (OR = 3.11); systemic lupus erythematosus, rheumatoid arthritis, or polymyalgia rheumatica (OR = 2.20).

Conclusion: Better adjustment for comorbidity may be obtained by identifying patients with a Charlson score 7 or greater. The consistent association between insomnia and serious disease of the liver warrants further investigation: hypothesized mechanisms include pain, confounding by alcoholism or the development of hepatic encephalopathy.

0741

THE SLEEP AND NEPHROLOGY OUTCOMES RESEARCH (SNORE) STUDY

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Introduction: Sleep apnea (SA) may accelerate progression of chronic kidney disease (CKD), but prospective studies addressing this question are lacking. We report preliminary findings of a 3-year prospective study of 250 veterans with CKD designed to determine: 1) association of SA with CKD progression; 2) association SA with quality of life (QOL) in CKD patients; and, 3) validity of a commonly used SA risk assessment tool in patients with CKD.

Methods: Veterans age 18-89 with at least 2 eGFR measurements 15-44 at least 3 months apart were invited to participate. Exclusion criteria included known SA, PAP/O₂ therapy, inability to consent, active cancer, life expectancy < 3 y, or solid organ transplant. Baseline measurements include full polysomnography, completion of KDQOL-SF, Epworth Sleepiness Scale (ESS) and Berlin Questionnaires, and eGFR and urinary albumin measurement. Renal function and KDQOL-SF will be reassessed annually during 3 y follow-up.

Results: After nine months, 95 patients have been enrolled. Mean age 75 ± 10 y; 98% male, 88% white, 49% DM, 95% HTN. Mean BMI 30 ± 4; mean eGFR 32 ± 9; median UACR 41 mg/gCr (IQR 12-200). 31% had ESS > 10 and 49% had Berlin score ≥ 2. Of the 30 scored sleep studies to date, 50% showed mild SA; 13% had moderate and 17% had severe SA. 30% of participants had ≥ 10% total sleep time with SaO₂ < 90%. 29% reported excellent/very good health. For QOL, mean physical component summary (PCS) score was 39 ± 10 and mental component summary (MCS) score was 51 ± 10. Burden of kidney disease and sleep domains were 80 ± 23 & 63 ± 18, respectively.

Conclusion: SA is common in veterans with CKD. QOL is comparable with published literature for CKD. The SNORE Study findings will be pivotal to our understanding of the impact of SA on CKD progression and related outcomes. Validation of a SA risk assessment tool in CKD will be an important for screening CKD patients for SA.

Support (If Any): Dr. Canales: VA CSR&D Career Development Award (CX000533-01A1).

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SLEEP DURATION ASSOCIATED WITH MARKERS OF KIDNEY FUNCTION IN PERSONS WITHOUT KIDNEY DISEASE: NHANES 2007-2010

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Introduction: Suboptimal sleep duration may contribute to the pathophysiology of chronic kidney disease (CKD) through alterations in the sympathetic nervous and renin-angiotensin-aldosterone systems. However, few studies have studied the relationship between sleep and indicators of kidney function. The purpose of this study was to examine the association between self-reported sleep duration and kidney function in persons without CKD.

Methods: Adults (≥ 20 years; N = 7,790) from the 2007-2010 National Health and Nutrition Examination Survey (NHANES) were assessed for their habitual sleep duration (coded as < 5, 5, 6, 7, 8, and 9+) and biomarkers of current kidney functioning including their urine albumin-to-creatinine ratio (UACR) and glomerular filtration rate (GFR) estimated from the Chronic Kidney Disease Epidemiology Collaboration equation. Participants were excluded if they were pregnant, had a previous sleep disorder diagnosis, or clinical indications of CKD (UACR

≥ 30 mg/g, GFR < 60 mL/min/1.73 m², or self-reported kidney/liver problems). Weighted multinomial and polynomial regression analyses assessed whether UACR and GFR varied across sleep duration groups after adjustment for age, sex, race/ethnicity, income, body mass index, and self-reported history of cardiovascular disease, heart failure, stroke, hypertension, and diabetes.

Results: After adjustment, sleep duration was associated with UACR both linearly ($p = .016$) and quadratically ($p = .02$), and GFR (only linear [$p = .022$]), such that elevated UACR was associated with shorter and longer sleep durations and higher GFR was associated with shorter sleep durations.

Conclusion: In an U.S. representative sample of adults without CKD or diagnosed sleep disorders, extremes in reported sleep duration were related to higher 24-hour urine albumin excretion and short sleep duration was associated with a higher rate of glomerular filtration. Future research is needed to understand whether these associations indicate increased risk for kidney damage and cardiovascular risk.

0743

PREVALENCE OF SLEEP DISORDERED BREATHING IN PATIENTS UNDERGOING CHRONIC INTERMITTENT DIALYSIS

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Introduction: Sleep disordered breathing (SDB) is a common finding in end stage renal disease (ESRD) patients undergoing intermittent hemodialysis (HD). The largest study on SBD prevalence in this population was performed using a questionnaire as screening tool. Our aim was to assess the prevalence of SDB in a European HD population using home polygraphy and to evaluate the predictive value of validated screening questionnaires, HD characteristics and biometric parameters.

Methods: All patients attending six HD centers in Switzerland were screened for SDB. Eligible patients completed the STOP-BANG questionnaire, the Berlin questionnaire (BQ) and the Epworth Sleepiness Scale (ESS). Apnea-Hypopnea Index (AHI) was assessed by a home nocturnal polygraphy.

Results: 101 patients completed the study. 86% of them had a SDB (AHI > 5 /h): 33% had mild (AHI 5-15/h), 22% moderate (AHI 15-30/h) and 31% severe SDB (AHI ≥ 30 /h). SBD had been previously diagnosed in 10% and was treated in 5% of patients. 14.4% of the patients had excessive sleepiness (ESS $> 10/24$). Positive (PPV) and negative predictive values (NPV) for moderate to severe SBD were 54% and 49% respectively for BQ, and 64% and 69% respectively for the STOP-BANG score. In univariate analysis, female gender, age, neck circumference, waist-to-hip ratio and time on renal replacement therapy (RRT) were associated with moderate to severe SBD, while BMI, dialysis adequacy (eKT/V) and weekly HD duration showed no association. Neck circumference (OR 1.31, $p < 0.01$) and time on RRT (OR 1.21, $p < 0.01$) were the only independent predictors of SBD in a multivariate analysis. Neck circumference was the best single predictor of moderate to severe SBD in our population, with a ROC curve area of 0.73. PPV and NPV were 77% and 66% respectively, using a cut-off of 41 cm.

Conclusion: In the HD population, we observed a high prevalence of SDB, which was largely underdiagnosed and undertreated. Classical screening tools and risk factors do not seem to be reliable for SDB screening in HD patients. Neck circumference and time on RRT emerged as the best predictors of SDB in this population.

Support (If Any): This study was supported by grants of the Schweizerische Nierenstiftung and the Ligue Pulmonaire Vaudoise.

0744

A PILOT STUDY EMPLOYING SIMULTANEOUS POLYSOMNOGRAPHY/CYSTOMETRY TO IDENTIFY COMBINED SLEEP/BLADDER DIARY CORRELATES OF NOCTURIA-ASSOCIATED DETRUSOR CONTRACTIONS IN SUBJECTS WITH OVERACTIVE BLADDER SYNDROME

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Introduction: Nocturia, defined as a void preceded and followed by sleep, has been poorly studied. We previously found that we could detect detrusor overactivity (DO), a hallmark of overactive bladder syndrome (OAB), occurring with nocturic-events with simultaneous polysomnography and cystometry (CMG). Further, DO occurred in OAB but not insomnia or healthy control subjects and was associated with several diary-derived indices of urinary function. Here we assessed whether these same diary-based variables can identify the subset of OAB patients with DO-associated nocturic-events.

Methods: The subjects were medication-free women with OAB without sleep disorders who had DO on daytime CMG. They also had ≥ 8 voids/24 h, > 1 episode of urinary urgency/day; and > 2 nocturia episodes/night on a combined bladder/sleep diary developed for this trial. We compared diary variables in subjects with (DO+) and without (DO-) at least 1 DO-associated nocturic event based on a one night laboratory assessment.

Results: Planned interim analysis was carried out in 15 subjects after which the study was stopped due to slow recruitment. CMG data were indeterminate in 2 subjects. We did not find any statistically significant differences between the 9 DO+ and 4 DO- subjects in the diary variables of interest. Notably, DO did not occur with every nocturic-event in 5/9 DO+ subjects and the 4 DO- subjects each had only 1 evaluable nocturic-event on the night studied.

Conclusion: DO does not precede every nocturic-event and recording fewer nocturic-events decreases the likelihood of capturing a DO. Given the lack of difference in urinary variables between groups, it seems likely that if enough nocturic-events were studied, all of our subjects would have been DO+. Further work will be needed to confirm whether diary information and daytime CMG can be used to identify the subset of OAB patient who are likely to have DOs prior to nocturic events.

0745

AGE-MEDIATED RELATIONSHIP BETWEEN PROSTATE SPECIFIC ANTIGEN LEVELS AND SHORT AND LONG SLEEP DURATION: A CROSS-SECTIONAL STUDY OF THE UNITED STATES.

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Introduction: Prostate specific antigen (PSA) has emerged as a marker of prostate cancer risk among men over age 40. The correlation between PSA and cancer risk increases with age and has been linked to inflammation. Habitual sleep has also been associated with age, inflammation and (to a lesser degree) cancer risk, indicating that sleep may influence PSA levels.

Methods: This study used representative data from the 2007-2008 NHANES. We restricted the sample to males ≥ 40 years old ($N = 1,479$) who provided analyzed PSA samples and complete data for other covariates. PSA levels were assessed using standardized assays. Sleep duration was assessed using self-reported hours slept, categorized as ≤ 4 , 5, 6, 7,

8, 9, and ≥ 10 hrs. Age was grouped in 5-year bins from 41-80+. Co-variables included race/ethnicity, education, income, smoking, body mass index, and log c-reactive protein levels. Population-weighted linear regression, with log PSA levels as outcome and sleep duration as predictor (reference = 7 h) were conducted across age groups.

Results: The age*sleep duration interaction was significant ($p < 0.0001$), justifying stratified analyses. Among those age 41-45, PSA was lower in 9 h ($B = -0.652$; 95%CI = $[-0.997, -0.308]$; $p < 0.0001$) and ≥ 10 h ($B = -0.311$, 95%CI = $[-0.612, -0.011]$; $p = 0.042$). PSA was higher in 9 h ($B = 0.804$; 95%CI = $[0.177, 1.430]$; $p = 0.012$) among those 46-50. Similarly, PSA was higher in 8 h ($B = 0.478$; 95%CI = $[0.010, 0.947]$; $p = 0.045$) and 9 h ($B = 0.648$; 95%CI = $[0.196, 1.099]$; $p = 0.005$) among those 51-56. PSA was lower in 9 h ($B = -0.648$; 95%CI = $[-1.250, -0.047]$; $p = 0.035$) for participants 56-60, and in 5 h ($B = -0.476$; 95%CI = $[-0.946, -0.007]$; $p = 0.047$) among participants 61-65. PSA was higher in ≥ 10 h ($B = 0.814$; 95%CI = $[0.131, 1.496]$; $p = 0.020$) among those 66-70, and those 71-75 ($B = 1.634$; 95%CI = $[0.021, 2.247]$; $p < 0.0001$). No relationships were found among participants in 66-70 group.

Conclusion: The association between sleep duration and PSA differs across age groups. The most robust relationships were seen between longer sleep and higher PSA among those aged 66-75 but lower PSA in those ≤ 45 . These could represent cohort effects in reporting, relationships with secondary variables, and changing risk profiles with age.

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0746

ABNORMAL OVERNIGHT OXIMETRY AND SLEEP DISORDERED BREATHING IN LIVER TRANSPLANT CANDIDATES

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Introduction: Abnormal nighttime oxygenation in patients with end stage liver disease has received scant attention. Overnight oximetry (OvOx) is used for screening nocturnal desaturation and sleep-disordered breathing (SDB). Our aim was to determine the frequency of and clinical associations with abnormal oxyhemoglobin saturation (SaO_2) via OvOx in liver transplant candidates.

Methods: We prospectively collected screening OvOx in consecutive adult patients listed for liver transplantation from August 2008 through March 2011. Abnormal OvOx was defined by the oxygen desaturation index (ODI) $\geq 5/\text{hr}$. A subgroup analysis was also performed by interpreting actual OvOx tracings to identify abnormal studies regardless of their ODI index. The Epworth Sleepiness Scale (ESS) was used for daytime sleepiness. For the statistical analysis, logistic regression was used.

Results: A total of 247 consecutive patients; 25% (61/247) had abnormal OvOx by ODI $\geq 5/\text{hr}$. Age, BMI, % of total sleep time spent $< 90\%$ SaO_2 , min SaO_2 , awake SaO_2 , direct bilirubin level, cardiac output and use of sleep aid medications were significantly ($p\text{-value} \leq 0.05$) different in ODI $\geq 5/\text{hr}$ group compared to ODI $< 5/\text{hr}$ group. Abnormal OvOx interpretation was documented (183/249 or 73.5%). In addition to the aforementioned variables, ESS, albumin, PaO_2 , A-a gradient, DLCO % predicted, RVSP, E/e ratio was also significantly related to nocturnal desaturation. No association was noted with Childs-Turcotte-Pugh, Model for End Stage Liver Disease, ascites or encephalopathy. Up to date, survival rate after transplant was similar (72%). 38% of ODI $\geq 5/\text{hr}$ group went on to have formal polysomnography (PSG).

Conclusion: In the largest cohort described to date, abnormal overnight oximetry suggesting SDB was common in patients awaiting liver trans-

plant. A minority of such patients underwent PSG. Further exploration of SDB in this patient population is warranted, since it may have implications in the peri-operative period, post-transplant course, and long-term outcomes.

0747

OBJECTIVE AND SUBJECTIVE SLEEP MEASURES PREDICT NEXT-DAY SYMPTOMS IN WOMEN WITH IRRITABLE BOWEL SYNDROME

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Introduction: Patients with irritable bowel syndrome (IBS) often report sleep disturbance, and prior research by our group has shown that self-reported sleep difficulties predict next-day gastrointestinal symptoms. The purpose of this study was to explore whether objectively measured sleep, as well as self-reports, predict next-day symptoms and to explore whether symptoms also predict self-report and objective sleep outcomes.

Methods: Women aged 18-45 years (mean = 32 ± 8 years) with IBS were recruited from the community ($n = 24$). Participants completed sleep and symptom diaries for 2 months and wore an Actiwatch-64® actigraph for 7 days. Only matched actigraphy and diary days were analyzed (4-7 days per subject). Statistical analyses used generalized estimating equation (GEE) models examining between-subjects effects (represented by the within-subject mean of the predictor) and within-subject effects (represented by the difference of each day from the within-subject mean of the predictor).

Results: In women with IBS, poorer self-reported sleep quality predicted higher abdominal pain, IBS symptoms, anxiety, and fatigue the next day ($p < .05$), but not depression. These same relationships were confirmed by actigraphic sleep efficiency, but prediction was weaker than self-report and only anxiety and fatigue reached significance. Using symptoms as predictors, the only significant relationship was that higher levels of anxiety predicted higher actigraphic sleep efficiency.

Conclusion: This study extends prior findings that self-reported sleep disturbance predicted next-day symptoms in women with IBS by confirming this relationship with an objective sleep measure. The study adds further evidence that sleep predicts symptoms, but not the converse. The positive relationship between anxiety and objective sleep efficiency bears further exploration. Overall, these findings suggest that sleep disturbance may be an important treatment target for reducing IBS symptoms.

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0748

PREVALENCE OF OBSTRUCTIVE SLEEP APNEA AND BARRETT'S ESOPHAGUS IN PATIENTS REFERRED FOR ESOPHAGOGASTRODUODENOSCOPY DUE TO REFLUX SYMPTOMS.

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Introduction: The relationship between obstructive sleep apnea (OSA) and gastroesophageal reflux (GERD) has been previously studied with mixed results. The arousals during obstructive sleep apnea (OSA) decrease the lower esophageal sphincter pressure, contributing to worsened nocturnal reflux. We hypothesize that the prevalence of OSA in

those undergoing esophagogastroduodenoscopy (EGD) for evaluation of GERD is higher than in the general population.

Methods: Retrospective chart review was performed in 174 adult patients seen in a Family Medicine EGD clinic from 07/01/2011 until 07/01/2013 whose initial complaint was GERD related. Patients referred for melena, occult stool blood, gastrointestinal malignancy, Barrett's surveillance, or unexplained weight-loss were excluded. Data collected included: age, sex, body mass index (BMI), indication for EGD, and diagnosis following EGD. Three subgroups were analyzed: Group 1 had PSG with OSA. Group 2 were Stop-Bang questionnaire (SBQ) positive, but no PSG. Group 3 were SBQ negative

Results: Across all groups 51 (29.5 %) were men, 20 (11.5%) had PSG with OSA, 49 (28.1%) were SBQ positive. Group 1: age 52.5 ± 9.3 (mean \pm standard deviation); and BMI 31.6 ± 4 . Group 2: age 58.2 ± 11 ; and BMI 35.5 ± 10.4 . Group 3: age 52.5 ± 14.7 ; and BMI 28.7 ± 8.1 . All three groups had a similar prevalence of erosive esophagitis at 6%. Prevalence of gastritis, across all groups: 48 (27.5%); Group 1: 6 (30%); Group 2: 15 (30%); and Group 3: 27 (25%). Prevalence of Barrett's esophagus Group 1: 3 (15%); Group 2: 7 (14%); and Group 3: 11 (10%).

Conclusion: The prevalence of OSA in patients undergoing EGD for evaluation of GERD symptoms is higher than in the general population. There is a statistically significant difference in BMI between patients with OSA and those without OSA. There was an increased prevalence of Barrett's esophagus in those with OSA or SBQ positive compared to those without OSA or SBQ negative.

0749

SLEEP DISTURBANCE AND POLYSOMNOGRAM (PSG) FINDINGS IN PATIENTS WITH MODERATE-SEVERE GASTROESOPHAGEAL REFLUX DISEASE (GERD) REFRACTORY TO PROTON PUMP INHIBITOR (PPI) THERAPY

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Introduction: Although most GERD patients respond to PPI therapy, 10-40% remain symptomatic. PPI non-responders have greater subjective sleep disturbance than responders. Mechanisms by which sleep disturbance might override PPI benefit include esophageal hypersensitivity associated with sleep deprivation and lower esophageal sphincter relaxation during prolonged sleep onset, arousals and awakenings. We evaluated subjective sleep measures and PSGs in 11 PPI-refractory GERD patients.

Methods: Nineteen PPI-refractory GERD patients (≥ 5 episodes heartburn/week, ≥ 2 nocturnal) were recruited for a pilot study of CPAP for nocturnal GERD. All completed instruments measuring GERD severity and sleep disturbance. 11 had PSG after instruction on omeprazole dosing and non-pharmacologic GERD interventions.

Results: (mean \pm SD): 16 women; age 46 ± 13.0 yr; BMI 29.2 ± 4.9 . Severity scores were high on the GERD Symptom Assessment Scale (2.49 ± 1.67) and Nocturnal-GERD Symptom Severity and Impact Questionnaire (2.73 ± 0.99). Medical Outcomes Sleep Scale (MOS-12) measures differed from MOS study values in direction of sleep disturbance including: "sleep problems index I and II" (58.3 ± 27.2 vs 28.3 ± 18.1 and 48.2 ± 20.7 vs 29.2 ± 18.0); "average sleep quantity" (5.7 ± 1.9 vs 6.9 ± 1.4) hr; and "optimal sleep" (32 vs 54%). Epworth scores averaged 10.4 ± 5.0 . One patient with apnea-hypopnea index (AHI) 90.8 was excluded from PSG analysis. In the remaining 10, AHI was: 9/hr (1); 3.6/hr (1) and < 1 /hr (8). PSG measures included: total sleep time 302 ± 89.6 min; sleep latency 41.6 ± 36.4 min; sleep efficiency $71.7 \pm 18.5\%$; WASO

91.1 ± 63.8 min; awakenings 31.4 ± 21.1 ; arousal index 13.8 ± 11.2 /hr; and stage N1 15.5 ± 7.7 min. Next-morning recall: sleep latency 70.5 ± 41.9 min (2 longer, 4 shorter, 4 same as usual); sleep time 372 ± 73.8 min (4 longer, 1 shorter, 5 same as usual); awakenings after sleep-onset 2.7 ± 2.9 .

Conclusion: PSGs documented short sleep time and fragmentation supporting subjective sleep disturbance in PPI-refractory GERD. Further studies are needed to understand the relationship between nocturnal awakenings/arousals and GERD symptoms in these patients.

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0750

THE PREVALENCE OF SLEEP DISORDERS IN THE CIRRHOTIC POPULATION: ARE WE MISSING SOMETHING?

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Introduction: Intermittent hypoxia, observed with OSA, is associated with hepatic injury and risk of fatty liver disease, but the interaction between cirrhosis and OSA has not been established. The aim of this study is to assess whether OSA risk correlates with degree of hepatic injury.

Methods: Patients with cirrhosis from a specialized liver clinic at an academic hospital completed self-reported questionnaires about sleep habits over the last 3 months, the Berlin questionnaire, the Epworth sleepiness scale (ESS) and demographic data. Patients were stratified into high versus low risk of OSA using the Berlin questionnaire. The model for end stage liver disease (MELD) score was calculated for each subject to assess hepatic injury. Analyses using Student's T-test and chi-squared tests were used to compare groups. Simple linear correlation coefficient was used to determine association of ESS with MELD. P-value < 0.05 was considered significant.

Results: Twenty cirrhotic patients were divided into high (n = 10) and low (n = 10) risk OSA groups. No significant differences were noted by age, gender, race, BMI and liver disease etiology between the two groups. Mean age of patients was 53.6 ± 5.8 (SD) with average MELD of 13.4 ± 4.1 (SD) and BMI of 27.6 ± 4.0 . 55% were male, and 65% of the patients in the study were Caucasian. ESS score was significantly elevated in the higher risk group (13.2 vs. 3.9, $p < 0.005$), as was MELD score (16.5 vs. 10.2, $p < 0.05$). Increased MELD was correlated with ESS ($r = 0.61$, $p < 0.05$).

Conclusion: The significant association between increased risk of OSA and ESS with higher MELD score supports the hypothesis that OSA may contribute to progression of cirrhosis. This finding needs to be validated with objective sleep data. The causal association needs to still be established, and the effect of OSA treatment on severity of cirrhosis explored.

0751

THE ASSOCIATION BETWEEN ROTATING SHIFT WORK AND IRRITABLE BOWEL SYNDROME: THE IMPACT OF CIRCADIAN MISALIGNMENT

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Introduction: Irritable bowel syndrome (IBS) is a common functional gastrointestinal disorder (FGID). Sleep disturbance, especially circadian misalignment, can apparently lower visceral perception thresholds and possibly leading to higher rate of FGID. Shift work is generally representative of sleep disorders in terms of circadian misalignment and

poor sleep quality. Studies showed some association between shift work and FGID. However, in Thailand, there are some differences in terms of prevalence and characteristic of circadian rhythm disorders, and FGID. We aim to compare the frequency of IBS between rotating shift and regular day nurses and to determine whether it was related to sleep quality or circadian misalignment.

Methods: The study was conducted at King Chulalongkorn Memorial Hospital, Bangkok, Thailand between January 2012 and December 2012. Nurses participating in the study were invited to complete Rome III, IBS-quality of life measure (IBS-QOL) and modified Sleep-50 questionnaires. They were subsequently classified into permanent day shifts and rotating shifts. The prevalence of IBS and associated risk factors were prospectively evaluated. Data shown as mean \pm S.D. and p-value less than 0.05 defined as significance.

Results: 317 nurses with mean age of 36.01 ± 9.39 years participated in the study (106 day shift and 208 rotating shift). Rotating shift nurses had a significantly higher prevalence of IBS compared to day shift nurses (19.71 vs. 10.38%, $p = 0.023$). Univariate analysis revealed that, in addition to rotating shift, sleep quality and stress were also associated with an increased prevalence of IBS (all $p < 0.05$). Multivariate analysis demonstrated that only rotating shift was independently related to IBS ($p < 0.05$), after adjusting for confounders.

Conclusion: Nurses participating in shift work, particularly those working rotating shifts, face a significantly increased risk of developing IBS that seems to be independent of sleep quality or stress. Circadian rhythm alterations may account for a part of pathogenesis of IBS.

0752

THE RELATIONSHIP BETWEEN SLEEP DISTURBANCE AND DEPRESSION IN PREDICTING CLINICAL DISEASE ACTIVITY IN PATIENTS WITH INFLAMMATORY BOWEL DISEASE

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Introduction: Patients with inflammatory bowel disease (IBD) have a high incidence of sleep disorders and other psychological comorbidities such as depression. Data from our group have shown a relationship between sleep disturbance and clinical disease activity and the presence of sleep disturbance has been shown to be a significant predictor of disease relapse independent of clinical disease activity. Depression is noted to be a common comorbidity in patients with insomnia, thus, in this study we have examined the relationship between sleep disturbance and depression in patients with IBD.

Methods: This is a prospective observational, cross sectional study which includes 70 patient diagnosed with either Crohn's disease or ulcerative colitis as assessed by the Harvey Bradshaw Index (Crohn's disease) or the Partial Mayo Score (ulcerative colitis). Sleep disturbance was assessed by the Pittsburgh Sleep Quality Index (PSQI) and depression was assessed by the Beck Depression Inventory for Primary Care (BDI-PC).

Results: The correlation between sleep disturbance and clinical disease activity was .43 ($P = .0002$). Overall 16% of the patients had an elevated (> 4) BDI-PC. Depressed patients had a significantly higher PSQI score (10.82 vs. 7.02 $P = .002$) compared to non-depressed patients. None of the patients with normal PSQI had an abnormal BDI. In the entire cohort the correlation of the BDI with the PSQI was .45 ($P < .0001$).

Conclusion: 1) Sleep disturbance is highly correlated with clinical disease activity. 2) Although a relatively low percent of patients had

significant elevation in depression score the correlation with the PSQI overall suggests that this relationship accounts for a substantial portion of the total variance. 3) Attention to both sleep disturbance and comorbid depression is an important element in optimizing the treatment of IBD patients.

0753

A SLEEP HYGIENE AND RELAXATION INTERVENTION FOR CHILDREN ON MAINTENANCE CHEMOTHERAPY FOR ACUTE LYMPHOBLASTIC LEUKEMIA (ALL): A PILOT RCT

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Introduction: Children being treated for cancer have poor sleep quality which contributes to increased fatigue, their most distressing treatment-related symptom. Sleep hygiene and relaxation techniques have improved sleep in healthy children with sleep problems, and adult cancer patients. We examined the feasibility, acceptability and effectiveness of a sleep hygiene and relaxation intervention for children receiving maintenance chemotherapy for ALL.

Methods: Children aged 4-10 and their parents were enrolled. Baseline sleep and fatigue data were collected; four weeks later participants were randomized. Once randomized, intervention group parents received an educational session on sleep and fatigue issues in children with cancer, and strategies to improve sleep hygiene. Relaxation to promote sleep was outlined using two children's books demonstrating deep breathing. Usual care participants received no sleep information. Sleep and fatigue data were collected 4 weeks post intervention for experimental, and 8 weeks post baseline for usual care participants.

Results: Eighteen children were randomized (mean age 5.7 years, 89% male). Completion of sleep diaries and actigraphy proved challenging for some participants. Families appreciated the educational session, and rated many of the tips as very helpful. Although not powered to detect differences between groups, analysis of actigraphy data indicated an increase of 43 minutes of nighttime sleep in the intervention group versus 25 minutes in the usual care group ($p = 0.56$). There were no statistically significant differences between groups on change in daytime sleep, number of nighttime awakenings, subjective sleep disturbance (CSHQ), or fatigue between baseline and 8 weeks later.

Conclusion: This pilot RCT indicates a sleep hygiene and relaxation intervention is feasible and acceptable for families with a child on maintenance chemotherapy for ALL. Further testing of the intervention in a large scale RCT, and in children with other types of cancer is needed.

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0754

SLEEP AND SURVIVAL IN WOMEN WITH ADVANCED BREAST CANCER

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Introduction: Self-reported sleep complaints are prevalent among cancer survivors and are often associated with poor quality of life. We have previously shown that such complaints are associated with shorter survival in women with advanced breast cancer. Using a prospective research design, this study aimed to clarify the relationship between ob-

jective measures of sleep with survival among women with advanced breast cancer.

Methods: Actigraphy was collected over three consecutive days in 97 women diagnosed with advanced breast cancer (age = 54.6 ± 9.8 years). Sleep and wake were scored with standard algorithms. Sleep efficiency was operationalized as the ratio of total sleep time to total sleep time plus wake after sleep onset.

Results: Greater sleep efficiency was found to predictive of a reduction in overall mortality (hazard ratio (HR) = 0.96, 95% CI: 0.94-0.98, $P < 0.001$) at median 6 years follow-up. This relationship remained significant (HR = 0.94, 95% CI: 0.91-0.97, $P < 0.001$) after adjusting for other known prognostic factors (age, estrogen receptor status, cancer treatment, metastatic spread, cortisol levels, depression). Complementary measures of sleep disruption followed this finding. After adjusting for baseline prognostic factors, less wake after sleep onset (HR = 0.42, 95% CI: 0.26-0.68, $P < 0.001$), fewer wake episodes, (HR = 0.93, 95% CI: 0.89-0.98, $P < 0.01$), and shorter wake episode duration (HR = 0.29, 95% CI: 0.14-0.59, $P < 0.001$) were all associated with reductions in overall mortality. Sleep duration (self-reported and actigraphy-derived) did not predict a reduction in overall mortality.

Conclusion: These findings suggest that greater sleep efficiency and less sleep disruption might play have role in reducing overall mortality from advanced breast cancer. A prospective intervention trial would be critical in determining the interaction between sleep and mortality in breast cancer. This may provide a window into the role of sleep in disease progression.

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0755

SLEEP AND CIRCADIAN RHYTHMS IN INDIVIDUALS RECEIVING TREATMENT FOR LUNG CANCER

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Introduction: The purpose of this study was to provide exploratory qualitative and quantitative data on sleep and circadian rhythms in individuals before, during and after treatment for non-small cell lung cancer (NSCLC).

Methods: A mixed method design used data collected at four time points (diagnosis, after the first and second chemotherapy treatments and at 6 months) in individuals newly diagnosed and scheduled for chemotherapy for inoperable NSCLC. Data from subjective and objective instruments evaluating sleep quality, daytime sleepiness, circadian rhythms and quality of life (QOL) outcomes were obtained. Concurrent with data collection, qualitative illness narratives were obtained to explore the participant experience of lung cancer and the effect on sleep patterns. Qualitative data were analyzed using interpretive phenomenology. Quantitative data were analyzed using descriptive inferential statistics. Matrices were created to compare and contrast both data sets to synthesize results.

Results: Among 29 participants, the mean age was 67 years, male (62%), Caucasian (83%), married (45%), retired (42%) with at least a high school education (77%). Mean nocturnal sleep quality was poor and circadian rhythms were disturbed prior to treatment and did not significantly change during or after treatment. Poor sleep and disturbed circadian rhythms were related to poor QOL and increased symptoms. Qualitative illness narratives were congruent with the quantitative measures demonstrating similar individual worsening or improvement in sleep overtime.

Conclusion: This study provides insight on improvement for sleep, circadian rhythms and QOL in individuals before, during and after treatment for NSCLC. Future research with larger samples will help elucidate physiologic (disease specific), behavioral (sleep hygiene), or emotional predictors (anxiety and depression with terminal illness).

Support (If Any): Oncology Nursing Society and National Lung Cancer Partnership Lung Cancer Grant.

0756

SLEEP AND CIRCADIAN ACTIVITY RHYTHMS AT THE END OF CHEMOTHERAPY PREDICT QUALITY OF LIFE ONE YEAR LATER IN WOMEN WITH BREAST CANCER

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Introduction: Women with breast cancer undergoing chemotherapy experience significantly disturbed sleep and circadian activity rhythms (CARs) during treatment and these disturbances often affect their quality of life (QoL). However, the long term effect of sleep and CARs disturbances during chemotherapy on QoL has not been reported.

Methods: Sixty women with newly diagnosed stage I-III breast cancer (mean age = 51.6 ± 9.0 years, range = 31-76) scheduled to receive at least 4 cycles of chemotherapy were included in this analysis. Subjective sleep disturbance was measured with the Pittsburgh Sleep Quality Index (PSQI), and objective sleep with actigraphy with total sleep time (TST) and total nap time (TNT) calculated; naps were defined as any ≥ 10 minutes of consecutive actigraphic sleep during daytime. CAR was also measured with actigraphy by fitting the activity data into an extended cosine model with the f-statistic calculated. QoL was assessed with the Functional Assessment of Cancer Therapy-Breast (FACT-B), and the Medical Outcomes Study Short Form (SF-36) with norm-based Physical Component Scale (PCS) score and Mental Component Scale (MCS) score calculated. Data were collected at the end of cycle 4 (Cycle-4) of chemotherapy and one year after the start of treatment (1-Year). Participants wore the actigraph for 72 consecutive hours and completed a set of questionnaires at each time point. Linear regression analysis was performed to explore the predictive relationships between QoL at 1-Year and sleep or CAR at Cycle-4.

Results: Total PSQI score at Cycle-4 was significantly associated with Total FACT-B score ($t = -4.36$, $p < 0.0001$, model-R-square = 0.324), PCS score ($t = -4.18$, $p = 0.0002$, model-R-square = 0.304), and MCS score ($t = -3.04$, $p = 0.0041$, model-R-square = 0.188) at 1-Year. PCS score at 1-Year was also associated with TNT at Cycle-4 ($t = -2.82$, $p = 0.0075$, model-R-square = 0.173). MCS score at 1-Year was also associated with f-statistic ($t = 2.17$, $p = 0.037$, model-R-square = 0.110) and TST ($t = 2.17$, $p = 0.037$, model-R-square = 0.110) at Cycle-4.

Conclusion: Poor sleep and disrupted CARs were associated with worse quality of life one year later in women undergoing chemotherapy for breast cancer. Specifically, worse breast cancer-related QoL and health-related QoL (HRQoL) at 1-Year were predicted by worse subjectively reported sleep quality at Cycle-4; better physical component of HRQoL at 1-Year was predicted by shorter nap time at Cycle-4; better mental component of HRQoL at 1-Year was predicted by more rhythmicity of CAR and longer TST at Cycle-4.

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0757

SLEEP DISORDERED BREATHING RISK AND ASSOCIATIONS WITH FATIGUE IN BREAST CANCER SURVIVORS

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Introduction: Sleep disordered breathing (SDB) among breast cancer survivors has received little attention and its associations with fatigue are poorly understood. We therefore evaluated the risk of SDB and its associations with fatigue among fatigued breast cancer survivors.

Methods: Women 18+ years of age with breast cancer were recruited into a randomized controlled trial. Eligible women had completed cancer treatments a minimum one year previously; complained of persistent fatigue (≥ 4 on the Brief Fatigue Inventory [BFI]); had no untreated medical or psychiatric conditions causing fatigue; had no other cancer diagnosis in the past 10 years; and had not participated in acupuncture or acupressure in the past 6 months. At baseline, participants completed the Berlin Questionnaire to assess SDB risk and the BFI to assess fatigue severity and interference with daily living.

Results: 199 women (58.1 ± 10.0 years of age, 4.7 ± 3.6 years since cancer diagnosis) have been recruited; 128 (64%) were classified as high risk for SDB. Compared to the low-risk group, high-risk women were older ($p < .01$), had higher BMIs ($p < .01$), and were more likely to be married, post-menopausal, of non-Hispanic ethnicity, and have lower household income ($ps < .05$). BFI Total (6.1 ± 1.3 vs. 5.7 ± 1.1 , $p < .03$) and Interference (35.6 ± 9.4 vs. 32.5 ± 8.3 , $p < .02$) scores were higher for high-risk vs. low-risk women, but Severity was not (19.8 ± 3.7 vs. 19.2 ± 3.3). In multivariate regression analyses, Berlin Questionnaire risk status did not significantly predict BFI Total or Interference Score after controlling for other covariates.

Conclusion: The majority of fatigued cancer survivors are at high risk for SDB and high-risk women report more total fatigue and greater fatigue-related interference. Corroboration with objective polysomnography is needed. SDB accounted for only a small amount of the variance in fatigue symptoms.

Support (If Any): NIH R01 CA151445 (S Zick).

0758

SLEEP, STRESS & HOME SYMPTOM MANAGEMENT IN CANCER PATIENT-CAREGIVER DYADS

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Introduction: To date, 41.4% of cancer patients and 50% of family caregivers experience insomnia that can result in chronic sleep deprivation (CSD). CSD results in mood disturbances that further perpetuate insomnia symptoms. Cancer patient experiences and family caregivers' responses to providing care to a loved one with cancer have been described separately; however, few have explored the dyadic interaction. And none have described the impact caregiver's CSD has on home symptom management. The purpose was to explore the relationships between patient and caregiver symptoms and caregivers' CSD impact on symptom management. Questions included: 1. What are the relationships between caregiver confidence with symptom management and caregiver sleep quality? 2. What are the dyadic relationships between patient and caregiver sleep, depressive symptoms and perceived stress?

Methods: A cross-sectional descriptive design was used. Participants were adult, English speaking cancer patient-caregiver dyads recruited at a large community cancer center in Texas. Following consent, par-

ticipants completed sleep (PSQI & ISI), mood (PSS & CESD), quality of life [patients] (FACT-G), and confidence in symptom management [caregivers] (investigator developed) questions.

Results: 25 dyads completed all items. Caregiver and patient mean ages were 61.2 and 59. Participants were 74% Caucasian, 14% Black, & 14% Latino. Sleep was moderately disturbed in caregivers and patients (PSQI $m = 8.7$ & 8.1 ; ISI $m = 8.1$ & 5.5). Mood was similarly disturbed (CESD $m = 13.6$ & 13.2 ; PSS $m = 22.0$ & 22.3). Dyadic models using indicators of ISI or PSQI to predict CESD were similar, suggesting that patient sleep quality, whether specific or global, is a significant predictor of depression. Relationship status and patient ISI were the most significant predictors of stress.

Conclusion: Sleep is important to home management of cancer symptoms. Dyadic interactions demonstrate that work is needed to explore longitudinal relationships and the impact sleep interventions may have on patient outcomes.

0759

PREVALENCE AND PREDICTORS OF INSOMNIA IN STEM CELL TRANSPLANT PATIENTS: A CONTROLLED COMPARISON

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Introduction: Allogeneic hematopoietic stem cell transplants (HCTs), in which patients undergo high-dose chemotherapy followed by infusion of blood stem cells from a donor, are increasingly used as treatment for hematologic malignancies. Allogeneic HCT recipients can experience a variety of medical complications that compromise quality of life, but little is known about insomnia in this population. This study aimed to examine prevalence of insomnia in HCT recipients from before transplant to 12 months later as well as pre-HCT predictors of insomnia over time.

Methods: HCT recipients ($n = 48$; 37% female, age $M = 53.74$, $SD = 14.27$) completed measures of sociodemographic information, insomnia severity (ISI), depression (CES-D), and anxiety (STAI) before transplant and 3 and 12 months later. Age- and geographically-matched controls ($n = 30$, 50% female, age $M = 54.88$, $SD = 13.11$) without cancer completed measures at similar intervals. Mixed models analyses were used. A cut-off of 8 was used to assess clinically-significant insomnia.

Results: Rates of insomnia for HCT recipients before transplant and at 3 and 12 months post-transplant were 46%, 51%, and 44%, respectively; rates of insomnia for controls were 17%, 21%, and 17%, respectively. Mean levels of insomnia severity were significantly higher in HCT recipients at baseline as well as 3 and 12 month follow-ups ($ps \leq .03$); neither group demonstrated change in levels of insomnia over time ($ps > .05$). Insomnia severity was not associated with age or gender ($ps > .05$). Among the HCT recipients, insomnia at 3 and 12 months post-transplant was predicted by more depression ($ps < .01$) but not anxiety ($ps > .05$).

Conclusion: This study, the first to use a validated measure of insomnia severity in HCT recipients before and after transplant, demonstrated high rates of insomnia in the HCT survivorship phase. It underscores the need for studies to examine interventions for sleep disturbance in this population.

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0760

PREDICTORS OF FATIGUE IN FIBROMYALGIA SYNDROME AND PATIENTS WITH OSTEOARTHRITIS*Yeung W¹, Morgan K¹, McKenna F²*¹Clinical Sleep Research Unit, Loughborough University, Loughborough, United Kingdom, ²Trafford General Hospital, Trafford, United Kingdom

Introduction: Compared to other clinical groups with chronic pain, people with fibromyalgia syndrome (FMS) report higher levels of fatigue. It is not known whether this is driven by pain, psychological mechanisms or sleep disturbance. This study compared fatigue outcomes in patients with FMS and osteoarthritis (OA). The patients were part of a larger clinical assessment of psychosocial and polysomnographic variables.

Methods: 20 recently diagnosed FMS patients (all females; M = 40.45, SD = 11.21) and 15 patients with OA (all females; M = 44.60, SD = 11.01) exhibiting localized joint pain and sleep disturbance were recruited from a single rheumatology facility at Trafford General Hospital, UK. All participants completed self-reported sleep, pain, fatigue, depression and anxiety measures. Multiple regression analysis was conducted with fatigue as the dependent variable and sleep, pain, depression and anxiety measures as predictors.

Results: The mean fatigue score in FMS was 51 ± 8.40 and 38.27 ± 10.92 in OA. The regression model was significant overall, $F(21, 10) = 4.63$, $p = .002$, $r^2 = .54$. After controlling for sleep quality, pain severity, pain interference, depression and anxiety, group membership was the only significant predictor of fatigue, $B = -7.55$, $t = -2.40$, $p = .026$.

Conclusion: This data shows that differences in fatigue noted in these two clinical groups are not solely driven by psychological factors. Other factors related to sleep structure may play a larger role in driving these differences.

0761

CHANGES IN SLEEP AND PAIN PREDICT GRAY MATTER CHANGES IN FIBROMYALGIA PATIENTS*Mundt JM, Craggs JG, Robinson ME, O'Shea AM, Staud R, Berry RB, Perlstein WM, Waxenberg LB, McCrae CS*

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Introduction: Insomnia occurs frequently among patients with fibromyalgia (FM). Neuroimaging studies have provided evidence of gray matter atrophy in individuals with FM. Our previous research found that individuals with comorbid FM and insomnia given cognitive behavioral therapy for insomnia (CBT-I) showed increased cortical thickness (CT) over the course of treatment, while those randomized to CBT for pain (CBT-P) or a control group experienced a decline in CT. The present study examined whether changes in sleep and pain were related to the observed increase in CT for CBT-I.

Methods: We examined the subset of participants in a larger trial who were randomized to CBT-I and also underwent optional MRI ($n = 14$). Pre- and post-treatment procedures included: MRI, PSG, and two weeks of sleep diaries and daily pain ratings.

Results: Hierarchical multiple regressions were conducted for the six brain regions (within the cingulate, frontal cortex, and temporal gyrus) previously shown to have significant treatment-related changes (DV: $CT\Delta$). $TST\Delta$ and $WASO\Delta$ were entered in the first step (the residualized quadratic term for $TST\Delta$ was used because scatterplots indicated a likely curvilinear relationship between $CT\Delta$ and $TST\Delta$), and $Pain\Delta$ was added in a second step. $TST\Delta$ was a significant predictor ($p < .05$) of $CT\Delta$ for five regions, and $Pain\Delta$ was a significant predictor for three regions. For the five significant models, R^2 range = .46-.74.

Conclusion: This study demonstrated that CT increases observed over the course of CBT-I were related primarily to improved sleep, while de-

creased pain also predicted increased thickness in some regions. However, the quadratic relationship between $TST\Delta$ and $CT\Delta$ suggests that while moderate increases in TST predicted cortical thickening, large increases were associated with cortical thinning, perhaps because a dramatic TST increase may be due to other unknown factors (e.g., worsening health, depression) with potentially deleterious effects on gray matter.

Support (If Any): R01AR055160, R01AR055160-S1.

0762

SLEEP DURATION MODERATES THE RELATIONSHIP BETWEEN CHRONIC KNEE OSTEOARTHRITIS AND LABORATORY PAIN SENSITIVITY*Redding MO¹, Campbell CM², Buenaver LF², Robinson ML², Swedberg LJ², Bounds SC², McCauley LM², Bockhorst AB², Robert ER³, Smith MT²*¹Psychiatry and Behavioral Sciences, Johns Hopkins University, Baltimore, MD, USA, ²Johns Hopkins University, Baltimore, MD, USA, ³Harvard Medical School, Brigham & Women's Hospital, Boston, MA, USA

Introduction: Quantitative sensory tests (QST) have shown that older adults with osteoarthritis exhibit hyperalgesia. Hyperalgesia has been linked to increased clinical pain reports in patients with mild radiographic evidence of OA. The clinical correlates of hyperalgesia are poorly understood. Experimental studies have found that sleep loss causes hyperalgesia in healthy pain free subjects. Little is known, however, about whether natural sleep loss in older adults is linked with quantitative sensory testing (QST) measures of pain sensitivity. The present study examines whether sleep duration moderates the relationship between OA and QST.

Methods: Participants were classified into two groups based on diagnostic eligibility criteria: knee OA (KOA) with or without insomnia disorder, and pain free, good sleeper controls. Polysomnography excluded participants with other sleep disorders. 178 total participants (83.7% KOA; 70.8% female, mean age = 60) underwent baseline testing including self-report measures (pain catastrophizing, depression, pain severity) and QST: pressure and heat pain threshold, temporal summation and cold pressor testing, which were Z-scored to create a general pain-sensitivity index. Sleep duration prior to QST was measured over for 2 weeks via actigraphy.

Results: Hierarchical regression examined the effects of sleep duration (TST) on the relationship between group status (KOA vs. healthy controls) and QST. Covariates included sex, age, race, clinical pain severity, depression, and pain catastrophizing. A significant group status by total sleep time interaction was observed ($p < 0.05$). Specifically, heightened pain sensitivity was associated with shorter sleep duration only among individuals with KOA.

Conclusion: These results suggest that shorter sleep duration may especially exert deleterious effects among pain populations. These findings highlight the importance of assessing and managing sleep in chronic pain patients. Elucidating the factors that contribute to chronic osteoarthritis pain and sleep disturbance is necessary for developing effective treatment and prevention strategies.

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0763

SELF-SHIATSU HAND MASSAGE TO PROMOTE SLEEP EFFICIENCY IN PERSONS WITH CHRONIC PAIN: A PILOT STUDY

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Introduction: Difficulty falling asleep is a common problem for persons living with pain. Research demonstrates that disrupted sleep will, in turn, exacerbate the chronic pain problem. The evidence-base for a range of pragmatic, non-pharmacological sleep interventions that can potentially be incorporated into pain management programs is growing. However, strategies that are controlled by the patient and are congruent with the self-management model favored by most pain services are not yet well researched. This study looks at the outcome of teaching adults with enduring musculoskeletal pain a standardized, pre-bedtime, self-administered Shiatsu hand massage (SHM) intervention to promote sleep onset.

Methods: A range of standardized sleep-related self-report tools and objective sleep actigraphy (recorded for 5-7 nights) were used to collect baseline data. Participants were then taught pre-bedtime self-administered SHM in one-to-one sessions. They also received two follow-up phone calls to offer support and clarification if needed. The assessment battery and 5-7 nights of actigraphy data were collected again at 2 weeks and 8 weeks post-SHM training.

Results: Twelve persons with diverse musculoskeletal pain experiences participated. Data collected at baseline, 2 week and 8 week follow-up periods revealed no apparent changes in actigraphy scores. Treatment fidelity dropped off at 8 week follow-up. A trend toward improved self-reported sleep latency (time to fall asleep) and sleep duration (time spent asleep) emerged. A number of participants reported they were more concerned with increasing their period of unbroken sleep as opposed to their total sleep time. None of the participants reported adverse effects of the intervention.

Conclusion: Preliminary findings of a low-cost, pragmatic, patient-controlled intervention are promising. Further study of self-administered SHM to determine the potential mechanism(s) at play, with greater control of treatment fidelity, and to investigate its use during nighttime awakenings in addition to pre-bedtime, are particularly indicated.

Support (If Any): Canadian CAM Research Fund (CCRF).

0764

CHRONIC PAIN AND EXCESSIVE SOMNOLENCE IN THE GENERAL POPULATION

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Introduction: Sleep disturbances are common in individuals experiencing chronic pain. Subjective measures of sleep in various chronic pain conditions mostly demonstrate a high number of complaints of disrupted and unrefreshing sleep. However, excessive somnolence. This study examines the associations between chronic pain and excessive somnolence.

Methods: This cross-sectional telephone study involved 15,945 individuals representative of the American adult general population (≥ 18 years) living in 15 states. Participants were interviewed on life and sleeping habits; health; medication consumption, medical conditions (ICD-10), sleep disorders (ICSD) and mental disorders (DSM-IV-TR) using Sleep-EVAL.

Results: Overall, 34.9% (95% confidence interval: 34.2% to 35.6%) of the sample reported having chronic pain: 9.1% of the sample had described it as a mild pain, 12.3% as a moderate pain and 13.3% as a severe pain. Severity of pain was significantly correlated with severity of sleepiness ($r = 0.16$; $p < 0.0001$): 18.8% of individuals with severe chronic pain had also severe somnolence. After adjusting for age, sex, presence of psychiatric disorders, sleep disorders and medical conditions, the presence of moderate chronic pain (OR: 1.5 [1.3-1.7] $p < 0.0001$) or severe chronic pain (OR: 1.8 [1.6-2.0] $p < 0.0001$) remained strong predictors of excessive somnolence. In fact, only the presence of sleep disorders more strongly associated with excessive somnolence (OR: 7.6 [6.8-8.5] $p < 0.0001$).

Conclusion: Chronic pain has been commonly associated with difficulty sleeping. It appears, however, it is also related to excessive somnolence independently of sleeping difficulty. Furthermore, the intensity of pain is correlated with the severity of somnolence: the greater the pain, the more severe the somnolence.

0765

SHARED YOGA PRACTICE FOR OSTEOARTHRITIS-RELATED INSOMNIA

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Introduction: Yoga is a multimodal intervention with the potential to reduce sleep disturbance in older adults with OA. In a previous pilot study by our research group, an 8-week yoga intervention significantly improved Insomnia Severity Index scores in women with OA and insomnia. The present study builds on this work by testing the feasibility and efficacy of a yoga program that addresses a novel aim of exploring whether attending the classes with a practice partner ("Shared Yoga") promotes adherence and improves outcomes.

Methods: Participants eligible for this RCT are persons aged 50-85 years who have a friend or family member that could attend the yoga classes with them. These dyads are randomized to Shared Yoga ($n = 10$) or Individual Yoga ($n = 10$). The 12-week intervention involves attending a weekly 75-minute class and performing the 30-minute daily home yoga practice.

Results: To date, 12 participants have enrolled (Shared $n = 7$, Individual $n = 5$), and 6 have completed the treatment ($n = 3$ per group). Mean attendance (out of 12 classes) was 7.8 for participants and 7.0 for partners. Pre-post comparisons in all subjects showed improvements on the ISI (-4.8 ± 5.8 points, or 30%, Wilcoxon signed-ranks $p = .08$); PROMIS Sleep Disturbance ($-34 \pm 27\%$, $p = .028$), Wake Disturbance ($-35 \pm 34\%$, $p = .046$), and Fatigue ($-20 \pm 37\%$, $p = .10$); and WOMAC Pain ($-28 \pm 28\%$, $p = .09$) and Function ($-20 \pm 24\%$, $p = .07$), but not Stiffness ($-9 \pm 32\%$, $p > .1$).

Conclusion: Preliminary findings suggest that a yoga program for arthritis may reduce sleep disturbance, pain, and fatigue. Final results from this trial will provide important information on the efficacy of an engaging intervention that could be disseminated in the community setting. The incorporation of social support to promote yoga practice is a novel approach, addressing an important factor for older adults in promoting adoption of and adherence to physical practice interventions such as yoga.

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0766

CHRONIC INSOMNIA SYMPTOMS IN EARLY ADOLESCENCE PREDICT NEURAL REWARD PROCESSING AND DEPRESSIVE SYMPTOMS

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Introduction: Insufficient sleep increases risk for depression, and it may do this by disrupting neural response to rewards. Neural systems that are involved in both reward processing and executive functions, such as the medial prefrontal cortex (mPFC), may be particularly vulnerable to sleep loss. In line with this model, this study tests the hypothesis that adolescents with chronic insomnia symptoms will have altered mPFC response to rewards and higher depressive symptoms relative to adolescents without chronic insomnia.

Methods: Participants were 120 adolescent girls followed in ongoing longitudinal study of precursors to depression. Participants' insomnia symptoms were assessed annually from ages 9- to 13-years and again at age 16-years using the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS). Trajectory analyses were applied to characterize the number and pattern of insomnia symptom groups. Participants also completed an fMRI monetary reward guessing task and K-SADS assessment of depressive symptoms at age 16. Group differences in mPFC response during reward anticipation were assessed by t-test, and conjunction and mediation analyses were performed to evaluate whether reward response in the mPFC would partially account for the relationship between insomnia burden and depressive symptoms.

Results: Trajectory analyses yielded adequate fit for a two-group model of insomnia symptoms (stable low insomnia, chronic high insomnia). Participants with chronic insomnia had greater response in the dorsal mPFC during anticipation of rewards relative to participants with low insomnia symptoms (cluster size = 635, $t = 2.78$, p -corrected $< .05$, MNI coordinates: -12, 50, 40). Furthermore, greater reward response in the dorsal mPFC partially mediated the relationship between insomnia and non-sleep depressive symptoms.

Conclusion: These data indicate that chronic insomnia symptoms across early adolescence are associated with greater mPFC response during anticipation of rewards, and this heightened mPFC response partially accounts for the association between insomnia burden and depressive symptoms.

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0767

ARE PATIENTS WITH CHILDHOOD ONSET OF INSOMNIA AND DEPRESSION MORE DIFFICULT TO TREAT THAN THOSE WITH ADULT ONSETS OF THESE DISORDERS?: A REPORT FROM THE TRIAD STUDY

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Introduction: Adult patients presenting with insomnia and depression represent a mixture of individuals with histories of childhood onset of sleep and mood disturbances as well as those with adult onsets of these conditions. Anecdotal observations suggest that those with childhood onsets of these conditions may be the more difficult

group to treat. This abstract reports results from analyses testing this assumption.

Methods: Participants included 27 (Age = 37.6 ± 13.8 yrs.) individuals with childhood onset-CO (before age 21) of insomnia and depression and 77 (Age = 48.2 ± 11.7 yrs.) with adult onset-AO of both disorders. All participants met DSM-IV criteria for major depression and insomnia and completed 16 weeks of treatment comprised of anti-depressant medication for their mood disturbances and a randomly assigned cognitive-behavioral or quasi-desensitization insomnia therapy. Participants completed the 17-item Hamilton Rating Scale for Depression (HRSD-17) and the Insomnia Severity Index (ISI) immediately before and after completing treatment.

Results: CO and AO groups did not differ (p 's > 0.80) in regard to their pre-treatment mean HRSD-17 (CO = 21.2 ± 4.1 ; AO = 21.4 ± 3.3) or ISI (CO = 18.7 ± 3.9 ; AO = 18.5 ± 4.2) scores and were equally distributed across insomnia treatments. At the end of treatment the AO group had significantly lower mean scores on the HRSD-17 (10.1 ± 7.20 vs. 14.2 ± 9.02 ; $p = 0.029$) and ISI (8.80 ± 6.8 vs. 12.2 ± 6.5 ; $p = 0.0352$) than did the CO group. Normative post-treatment HRSD-17 scores < 8 were achieved by 44.3% in the AO group and only 20.8% of those in the CO group ($p = 0.0414$). Normative post-treatment ISI scores (< 8) were achieved by 47.9% of the AO group and 29.2% of the CO group ($p = 0.1094$).

Conclusion: Results support the notion that patients with childhood onset of depression and insomnia are more treatment refractory than are those with adult onsets of these comorbid disorders. Further research is needed to identify therapies that enhance the depression and insomnia outcomes among those with childhood onset of these conditions.

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WHEN ACCOUNTING FOR WAKEFULNESS, COMPLETED SUICIDES EXHIBIT AN INCREASED LIKELIHOOD DURING CIRCADIAN NIGHT

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Introduction: Very few studies have examined the temporal patterning of suicide across the 24-hour day. The results of these investigations suggest that more suicides occur during the day. These findings are based on the assumption that the hour-to-hour probability for suicide is equal. This is unlikely because the at-risk population (i.e., the denominator for the suicide rate) changes with time-of-day. The present analysis evaluates the incidence of suicide by clock time while accounting for the proportion of the population that is awake at each given hour.

Methods: Archival analyses were conducted on the National Violent Death Reporting System (estimated time of fatal injury) and the American Time Use Survey (hourly proportion of the American population awake). To describe circadian patterning, time of fatal injury was categorized into one-hour bins. The hourly distribution of these data were weighted by the proportion of people awake at each hour and then were assessed by a Chi-square goodness-of-fit test and by contingency analysis for binned data across four times intervals: nighttime (00:00-05:59), morning (06:00-11:59), afternoon (12:00-17:59) and evening (18:00-23:59). A total of 35,332 suicides were included in the present analysis.

Results: When prevalence of suicide was weighted by the proportion of the population awake and scaled to 100%, there was little variation between 06:00-23:59, with a mean incident rate per hour of $2.13\% \pm 0.67\%$. In contrast, the night data exhibited higher values (mean $10.27\% \pm 4.92\%$), with a maximum of 16.27% at 02:00-02:59. Hour-by-hour observed values differed from those that would be expected by chance ($p < 0.0001$), and when the 6-hour blocks were examined, the observed frequency at night was 3.6 times higher than expected ($p < 0.0001$).

Conclusion: The present analysis adds a circadian perspective to the emerging literature which suggests that insomnia, nightmares, and sleep deprivation are potential contributors to suicidal ideation and attempted and completed suicide.

0769

SLEEP QUALITY IN PREGNANCY PREDICTS POSTPARTUM DEPRESSION AND STRESS

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Introduction: Rates of perinatal depression remain high and are associated with mental and physical health problems for mothers and their babies. In general populations and in pregnant women, sleep has been investigated as a contributing factor for depression. Whether or not pregnancy sleep affects postpartum mood and functioning remains unclear. Antidepressant treatment also affects sleep quality but has not been examined as a factor in the relationship between sleep and ongoing depression.

Methods: 192 pregnant women (mean age 28.15 [SD = 5.727], 34.6% minority, 38.1% low SES, 44.7% unmarried, 45.2% with major depressive disorder (MDD) during pregnancy, and 39% with serotonin reuptake inhibitor (SRI) treatment participated in this study. Depression status was obtained with the Structured Clinical Interview for DSM-IV Psychiatric Diagnoses. Level of depressive symptoms was obtained with the Inventory of Depressive Symptomatology (IDS) and level of stress with the Perceived Stress Questionnaire (PSQ). The Pittsburgh Sleep Quality Index (PSQI) was utilized to measure sleep quality. All measures were administered in the second and third trimesters of pregnancy and one month postpartum.

Results: Using hierarchical linear regressions, adjusted for income and maternal education status, pregnancy PSQI scores explained 3.2% of the variance of postpartum IDS scores ($p < .001$) above and beyond the variance explained by pregnancy IDS scores and SRI treatment. SRI treatment was associated with higher PSQI scores even when MDD remitted. Pregnancy PSQI scores also explained 1.7% of the variance of postpartum PSQ scores ($p < .011$), beyond the variance explained by postpartum IDS scores.

Conclusion: In a large sample of women, there is a unique effect of pregnancy sleep quality on postpartum depression and stress regardless of pharmacological treatment. These findings support prenatal sleep quality as a protective factor for postpartum depression and stress that could lead to high-impact avenues for improving perinatal health.

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0770

YOU'LL FEEL BETTER IN THE MORNING: SLOW WAVE ACTIVITY AND OVERNIGHT MOOD REGULATION IN BIPOLAR DISORDER

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Introduction: Sleep disturbances are a prominent correlate of mood episodes and inadequate recovery in bipolar disorder, yet the mechanistic relationship between sleep physiology and mood remains poorly understood. The present study investigated the association between mood dysregulation and deficient sleep homeostasis during the interepisode phase of bipolar disorder.

Methods: Adults with interepisode bipolar disorder (BD; $n = 24$) and healthy controls (CTL; $n = 26$) slept in the laboratory for 2 baseline nights, a sad mood induction night, and a happy mood induction night. Spectral analysis was conducted on sleep EEG recordings. Relative slow wave activity (SWA; 0.75-4.75 Hz) during non-rapid eye movement sleep indexed sleep homeostasis. An affect grid pleasantness rating measured mood post-mood induction and the following morning. Repeated-measures ANOVAs and chi-square tests assessed for mood-induced changes in SWA. Correlations evaluated the relation between SWA and overnight mood change.

Results: Baseline SWA did not differ between groups. A greater proportion of BD patients experienced a reduction in SWA following the sad mood induction relative to CTLs (55.0% vs. 21.7% ; $\chi^2(1) = 5.07$, $p = 0.024$). In the BD group, those with reduced SWA after the sad induction had longer illness duration (19.0 vs. 11.5 yrs; $t(18) = 2.13$, $p = 0.047$). Reduced SWA following the sad mood induction correlated with impaired overnight negative mood improvement in the BD group ($r = 0.89$, $p < 0.001$), while this relationship was not observed in CTLs ($r = -0.01$, $p = 0.968$). Following the happy mood induction, both groups experienced an increase in SWA compared to baseline ($F(1,41) = 4.56$, $p = 0.039$), though SWA was not related to overnight mood change.

Conclusion: Interepisode bipolar patients may be more vulnerable to negative mood-related SWA disruptions, which in turn serve to sustain negative mood from the previous day. Furthermore, positive mood can enhance SWA in bipolar patients and healthy adults.

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0771

A SEVEN-DAY ACTIGRAPHY BASED STUDY OF SLEEP DISTURBANCE IN HIGH TRAIT RUMINATORS

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Introduction: A small yet growing literature suggests that trait ruminators exhibit higher levels of sleep disturbance than those without this cognitive vulnerability. However, the sleep disruptive effects of state rumination, especially in the pre-sleep period, are less well documented. Further, extant studies in this area have relied solely on self-report and single night assays of sleep. Therefore, the present study employed a week-long, daily sampling approach to examine the effects of naturally occurring pre-sleep rumination on self-reported and actigraphy-based sleep.

Methods: Forty-two university students (19.6 ± 3.2 yo; 73.8% female) with high scores ($M+1.5$ SDs) on the Response Style Questionnaire-Rumination scale completed a short questionnaire after waking each morning for a period of seven days. This questionnaire assessed levels of pre-sleep rumination as well as sleep quality/duration. Sleep was monitored during this seven-day period in participants' home environments via wrist actigraphy. Hierarchical-linear-modeling was used to assess the impact of rumination on sleep, while controlling for gender and baseline levels of sleep disturbance (Global PSQI: 8.02 ± 3.45) and depressive symptoms (BDI-II: 37.03 ± 9.94).

Results: Nightly elevations in pre-sleep rumination were predictive of significantly longer actigraphy-based ($z = 3.47$, $p < .01$) and self-reported sleep onset latency ($z = 3.08$, $p < .01$), after controlling for baseline PSQI and BDI-II scores. Notably, a 1 SD increase on the pre-sleep rumination scale was associated with an approximately 7 minute increase in actigraphy-based SOL.

Conclusion: The present study is the first to establish an association between naturalistic variations in pre-sleep rumination and both objective and self-reported sleep disturbance. These data offer compelling evidence for the impact of pre-sleep rumination on sleep, and, as such, offer insight into the frequency and severity of sleep disturbance in disorders such as depression that are characterized by a ruminative stress response style.

Support (If Any): This study was supported by a research fellowship from Kent State University to Dr. Vivek Pillai.

0772

NEUROBIOLOGICAL EFFECTS OF PRAZOSIN ON NREM SLEEP IN VETERANS WITH PTSD

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Introduction: Sleep disturbances are a core feature of PTSD. Prazosin has been shown to significantly improve sleep in PTSD. We explored how prazosin affects regional cerebral metabolic rate of glucose use (rCMRglc) during NREM relative to wakefulness using 18F-FDG PET sleep neuroimaging methods.

Methods: Nine veterans with PTSD were randomized to prazosin treatment (mean age = 29.8 SD = 6.5 ; 6 men) and 13 to placebo (mean age = 27.2 SD = 6.3 ; 9 men) for an eight-week RCT. All veterans completed pre- and post-treatment 18F-FDG PET studies during wakefulness and NREM sleep. A State \times Time interaction analysis was performed using SPM 8 to determine the change in Wake-NREM rCMRglc changes from pre- to post-treatment. Post-hoc analyses were conducted to examine pre- to post-treatment changes in the NREM and Wake states separately. The corrected significance threshold was set at $p < 0.05$.

Results: No significant State \times Time interaction was detected in the placebo groups. Pre- to post-treatment, prazosin was associated with a greater increase in rCMRglc from wakefulness to NREM sleep in one cluster (7,013 voxels; MNI coordinate = 26, 22, 40; $Z = 3.76$, $p_{FWE} = 0.039$) including the right hippocampus and parahippocampus, amygdala, insula, prefrontal and associative temporal and parietal areas. In addition, prazosin was associated with a significant decrease in rCMRglc in one cluster (15,586 voxels, coordinate = -36, -74, 0; $Z = 3.78$, $p_{FWE} < 0.001$). This included the left putamen, claustrum, posterior cingulate, cerebellum, prefrontal and associative temporal, parietal and occipital areas. Post-hoc analyses revealed that these patterns were attributable to post-treatment changes in rCMRglc during NREM sleep. No changes were detected during wakefulness in the prazosin group.

Conclusion: The exploratory findings suggest that prazosin directly impacts rCMRglc during NREM sleep. Its benefits on sleep complaints

may result from metabolic changes affecting regions involved in hippocampal-dependent memory contextualization processes.

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0773

THE RELATIONSHIP BETWEEN CORTISOL OUTPUT AND SLEEP EEG IN AUTISTIC AND TYPICALLY DEVELOPED ADULTS

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Introduction: Higher cortisol output is known to correlate with poor sleep. Sleep in autism is characterized by disorders such as increased awakenings and less slow wave sleep (SWS) compared to typically developed individuals. This study explores the relationship between saliva cortisol levels and sleep in young adults with and without autism, none of which complaining subjectively of poor sleep.

Methods: Thirteen individuals with high functioning autism (HFA: 12M, 1F, 22.2 ± 3.7 years) and 12 typically developed individuals (TYP: 11M, 1F, 21.8 ± 4.2 years) were recorded for two consecutive nights. All had a normal IQ and none complained subjectively of poor sleep and none were taking medications. Saliva cortisol was measured five times in the evening and twice in the morning. The correlation between cortisol levels and variables usually associated with poor sleep was tested using Pearson correlation coefficients.

Results: The TYP and HFA groups showed a comparable salivary cortisol rhythm, with steady low levels in the evening and high levels in the morning. The TYP group showed a significant positive correlation between evening cortisol levels and the number and duration of nocturnal awakenings as well as a significant negative correlation with sleep duration. The TYP group also showed a negative correlation between evening cortisol and EEG delta activity in SWS over occipital region. In the HFA group, evening cortisol was correlated negatively with the duration of stage 4 SWS and with EEG delta activity over prefrontal and central regions but not with the number and duration of nocturnal awakenings. Sleep spindles and K-complexes, two EEG markers of cortical sleep protective mechanisms, showed no relationships with cortisol in the control group; K-complexes in the ASD group were associated with morning cortisol.

Conclusion: Young adults with autism showed a significant association between high salivary cortisol output and signs of poor sleep, but the relationship pattern was different from that of their typically developed counterpart: less SWS and low levels of slow EEG activity rather than awakening per se were associated with cortisol output. This atypical relationship pattern between sleep markers and cortisol levels possibly reflects an alternative coupling between neuronal and endocrine mechanisms of sleep control in autism.

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0774

IS NIGHTMARE DISORDER A FORM OF SUB-CLINICAL PTSD?

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Introduction: Nightmare Disorder (NMD) is by definition not due to trauma but its similarities to post-traumatic stress disorder (PTSD) raise the possibility that it may be a sub-clinical form of PTSD and thus a treatable risk factor for it. Like PTSD, NMD is frequent among adults with histories of abuse and produces significant distress, including disordered sleep.

Methods: The PTSD checklist is a 17-item questionnaire rating the frequency of DSM-IV symptoms for PTSD, including intrusions, re-experiencing, and avoidance. The Traumatic Antecedents Questionnaire measures lifetime traumatic experiences in 10 domains: competence, safety, neglect, separations, emotional, physical, or sexual abuse, conflict, witnessing trauma and drugs or alcohol; each domain is assessed at four different age ranges: 0 to 6, 7 to 12, 13 to 18, and adulthood. 28 subjects, including 14 NMD (age = 22.7 ± 3.7) and 14 matched controls (age = 23.3 ± 3.3) completed these questionnaires. NMD subjects recalled more bad dreams (NMD = 2.8 ± 1.4 , CTL = 0.3 ± 0.5 , Z-adjusted = 4.4, $p < 0.001$) and nightmares per week (NMD = 1.9 ± 1.4 , CTL = 0.0 ± 0.0 , Z-adjusted = 4.8, $p < 0.001$) than healthy controls.

Results: On the PTSD checklist, NMD subjects had higher global scores (NMD = 39.6 ± 14.3 , CTL = 28.6 ± 10.5 , Z-adjusted = 2.1, $p = 0.04$), intrusions (NMD = 13.4 ± 5.0 , CTL = 8.2 ± 4.6 , Z-adjusted = 2.8, $p < 0.01$), and avoidance (NMD = 11.9 ± 4.5 , CTL = 8.9 ± 2.9 , Z-adjusted = 1.7, $p = 0.09$) than healthy controls. On the Traumatic Antecedents Questionnaires, NMD subjects had higher emotional (NMD = 3.5 ± 3.6 , CTL = 1.2 ± 1.9 , Z-adjusted = 2.3, $p = 0.02$) and physical abuse in adulthood (NMD = 4.3 ± 4.6 , CTL = 0.9 ± 1.6 , Z-adjusted = 2.7, $p < 0.01$) than healthy controls. NMD subjects also tended to have higher neglect at ages 0-6 (NMD = 0.9 ± 1.5 , CTL = 0.1 ± 0.3 , Z-adjusted = 1.9, $p = 0.06$) and 7-12 (NMD = 1.5 ± 2.1 , CTL = 0.3 ± 0.6 , Z-adjusted = 1.7, $p = 0.08$) and higher sexual abuse at ages 0-6 (NMD = 1.2 ± 2.2 , CTL = 0.1 ± 0.4 , Z-adjusted = 1.8, $p = 0.07$) than healthy controls.

Conclusion: NMD patients express higher lifetime traumatic experiences than controls, conforming to the stipulation that nightmares appear after accumulation of low-grade stressors. Thus 'broad-spectrum' instruments, such as the Traumatic Antecedents Questionnaire and the PTSD checklist, may be useful in recognizing NMD as a form of sub-clinical PTSD.

Support (If Any): Canadian Institutes of Health Research (CIHR).

0775

NIGHT SWEATING, SUICIDALITY AND AUTONOMIC NERVOUS SYSTEM (ANS) HYPERAROUSAL IN POSTTRAUMATIC STRESS DISORDER (PTSD): CLINICAL FEATURES AND TREATMENT WITH MOOD STABILIZERS

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Introduction: Autonomic nervous system (ANS) dysregulation and hyperarousal are core features of PTSD. Hyperhidrosis (excessive sweating) is a symptom of ANS hyperarousal. There is only one case report (Rietsema WJ, 2003) describing an association between night-sweats and PTSD. We examined the frequency of night-sweats and related clinical features of ANS hyperarousal e.g., suicidal ideation in PTSD patients.

Methods: 20 patients (all female, mean \pm SD age: 45.6 ± 6.2 years, 18 white) with chronic PTSD (DSMIV-TR) and 20 age and sex-matched controls with Mood Disorders (DSMIV-TR), were evaluated for somatic complaints related to ANS hyperarousal, including hyperhidrosis and night-sweats. Suicidality was measured with the Beck Scale for Suicidal Ideation (BSS).

Results: 12/20 (60%) of PTSD patients [versus 1/20 (5%) of controls] reported night-sweats at least once per week. All investigations for possible causes of night-sweats e.g., tuberculosis, malignancy, recent onset menopause, were negative. Clinically there was no obstructive sleep apnea. The patients described profuse night-sweats in association with exacerbations of their PTSD. Their bedclothes would be 'drenched in sweat' and they would sometimes 'wake up and wring the sweat out of their clothes'. During the daytime patients described periods, wherein they perspired much more easily e.g., after minimal exertion. 10/12 PTSD patients with night-sweats also endorsed heightened suicidality, and 4/12 had attempted suicide. All PTSD patients were treated with mood stabilizers (e.g., lithium carbonate up to 900 mgs qhs, lamotrigine up to 150 mgs qhs) for management of the ANS hyperarousal, which was associated with a significant improvement in both night-sweats and suicidality (all BSS scores < 3 , within 3-4 weeks).

Conclusion: Night-sweats and sometimes daytime hyperhidrosis can be dermatologic manifestations of ANS hyperarousal in PTSD. Management with mood stabilizers was associated with a significant improvement in both night-sweats and psychiatric symptoms associated with ANS hyperarousal e.g., suicidality.

0776

THE RELATIONSHIP BETWEEN THE NUMBER OF TRAUMATIC EVENTS EXPERIENCED AND TRAUMA-RELATED SLEEP DISTURBANCES AMONG U.S. ADULTS

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Introduction: Individuals experiencing traumatic life events report sleep disturbances such as insomnia and nightmares. Trauma-related sleep disturbances soon after a traumatic event are positive predictors of PTSD development. Researchers have hypothesized that the number of traumatic events experienced may increase the risk for developing trauma-related sleep disturbances.

Methods: The National Stressful Events Survey (NSES), a structured online interview, was conducted with a large sample recruited from a probability-based online panel of U.S. adults, assessing for exposure to stressful events, as well as PTSD symptoms including insomnia (restless sleep or trouble getting to sleep or staying asleep) and trauma-related nightmares. Of the 2793 reporting exposure to at least one, and as high as ten, stressful event(s), most were female (51.6%), White (80.5%), had at least a high school degree (96.9%), and were age 45 or older (53%).

Results: Logistic regression analyses revealed that the number of traumatic events experienced significantly predicted trauma-related insomnia (OR = 1.24, 95%CI 1.19, 1.29), even after including gender which was also a significant predictor (OR = 2.60, 95%CI 2.18, 3.09). Parallel analyses revealed that number of events also significantly predicted nightmares (OR = 1.33, 95%CI 1.28, 1.38) along with gender included in the equation (OR = 2.61, 95%CI 2.16, 3.14). Significance also remained after controlling for race. Descriptive data are presented about sleep disorder prevalence as a function of number of traumatic events and gender. Differences in prevalence of sleep disturbances varying by specific traumatic event type were also examined.

Conclusion: The number of traumatic events experienced significantly predicts and increases the risk for both trauma-related nightmares and insomnia. Additionally, sleep disturbances vary depending on race and gender. These results are especially important because they are from a

population-based sample of individuals, rather than individuals seeking treatment for sleep disturbances, and utilized DSM-5 PTSD diagnostic criteria. Implications for future research and treatment are discussed.

0777

SLEEP QUALITY AND PTSD SYMPTOM SEVERITY: DAYTIME DYSFUNCTION AS A PREDICTOR OF EMOTION REGULATION DIFFICULTIES

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Introduction: Sleep disruption has been suggested as a hallmark symptom of PTSD. Research also suggests sleep problems and PTSD as predictors of emotion regulation (ER) difficulties. However, current research has not examined specific sleep problem domains that may influence ER difficulties in relation to PTSD. The current study examined specific sleep problem domains as predictors of ER difficulties when accounting for PTSD symptom severity.

Methods: Data were collected from 947 undergraduate participants. A subsample of 609 undergraduate participants who reported experiencing at least one traumatic event was used for data analyses. The constructs of interest were assessed using validated measures of PTSD symptom severity, PTSD-related sleep disturbance, ER difficulties, and sleep quality domains.

Results: Multiple regression analyses were used to investigate the relationship between the variables of interest, controlling for PTSD and PTSD-related sleep disturbance as potential covariates. Results indicated poor global sleep disturbances as a significant predictor of ER difficulties ($R^2 = .223$, $p < .01$). Further multiple regression analyses revealed the daytime dysfunction domain of sleep disturbance as a significant predictor of ER difficulties ($R^2 = .239$, $p < .01$).

Conclusion: The current study supports previous findings of sleep disturbance as a predictor of emotion regulation difficulties. However, the findings suggest that daytime dysfunction may have an influence on ER difficulties even after controlling for PTSD symptoms and disorder-specific sleep disturbance. The findings suggest that disrupted sleep quality, specifically daytime dysfunction, may exacerbate the negative outcomes related to PTSD (e.g., ER difficulties) within the context of a traumatic exposure.

0778

SLEEP DISTURBANCES AND EMOTIONAL MEMORY PROCESSING IN PTSD PATIENTS

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Introduction: Sleep appears to play an important role in emotional recovery and resilience. Disturbed sleep is one of the key symptoms of posttraumatic stress disorder (PTSD) and may contribute to the genesis and maintenance of PTSD. Our previously published sleep study, executed in healthy subjects, suggests that adaptive changes occur in sleep architecture after emotional experiences, which benefit emotional housekeeping and the attenuation of emotional responses to negative emotional experiences. Little is known, however, about the relation between sleep and emotional memory processing in PTSD.

Methods: The current study assesses the impact of an emotional stressor on sleep parameters in PTSD patients, including the distribution of sleep

stages, REM sleep-related variables and EEG power spectral parameters. Traumatized police officers and veterans with and without PTSD, and non-trauma exposed controls are compared. The experimental setup involves presentation of neutral or distressing film fragments in the evening, followed by full polysomnography of undisturbed, whole night sleep, and cued recall of film content on the next evening. The order of the film conditions is counterbalanced across subjects. Emotional and physiological state (ECG, respiratory effort, Galvanic skin response and plethysmogram) are assessed before and after film viewing and recall.

Results: We present preliminary results on sleep architecture in a sample of 13 patients. Previous polysomnographic studies report a largely intact, or mildly disrupted (macro)sleep architecture in PTSD patients, with sufficient non-REM- and REM-sleep. In contrast we found a strong increase of superficial sleep (stage N1; $t = 10.51$, $p < 0.001$) and decrease of deep sleep (stage N3; $t = -6.22$, $p < 0.001$). Effects of the emotional stressor on sleep architecture are not statistically significant in this preliminary sample.

Conclusion: Contrary to the literature sleep architecture appears to be altered in PTSD patients towards a more superficial sleep, with increased light sleep and little deep sleep.

0779

USING CANNABIS TO HELP YOU SLEEP: HEIGHTENED FREQUENCY OF MEDICAL CANNABIS USE AMONG THOSE WITH PTSD

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Introduction: The use of cannabis for medical purposes is steadily increasing in the United States. Research has indicated that individuals with posttraumatic stress disorder (PTSD) often report using cannabis as a means to cope with their symptoms, and that doing so results in more frequent and problematic use patterns. However, to date, specific coping motivations, such as sleep improvement, particularly among medical cannabis users, have not been examined.

Methods: The present study evaluated sleep-oriented cannabis use motivation, frequency of cannabis and alcohol use, and mental health among a sample of patients (N = 170) at a medical cannabis dispensary in California.

Results: Individuals with elevated PTSD symptoms were more likely to use cannabis with the goal of improving sleep, compared with those with low PTSD symptoms. An interaction test revealed that cannabis use frequency was greater among those with elevated PTSD symptoms who used for sleep promoting purposes compared with those with low PTSD symptoms or those who did not use for sleep purposes.

Conclusion: The current study suggests that sleep improvement is a primary motivator for coping-oriented use among those with PTSD, and that the combination of elevated PTSD and use for sleep improvement is associated with particularly heightened cannabis use. Additional research is needed to examine the health consequences of this pattern of cannabis use and whether alternative sleep promoting interventions (e.g. CBT-I) could reduce the reliance on cannabis use for adequate sleep among those with PTSD.

0780

DO SLEEP DISTURBANCES INFLUENCE GENERAL FUNCTIONING AFTER POSTTRAUMATIC STRESS DISORDER TREATMENTS?

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Introduction: Chronic insomnia and nightmares are prominent features of posttraumatic stress disorder (PTSD). There is evidence that these sleep disturbances may not respond to trauma-focused therapies for PTSD and may be associated with poor functional outcomes. Little is known about the effects of trauma-focused treatment on sleep disturbance and general functioning in adolescents with PTSD. The present study examined the effects of trauma-focused therapy on sleep-related PTSD symptoms, and the effect of disturbed sleep on general functioning.

Methods: Sixty-one adolescent females ages 13-18 ($M = 15.34$, $SD = 1.54$) seeking treatment at a rape crisis center for PTSD related to sexual assault participated in a single-blind randomized clinical trial of prolonged exposure for adolescents (PE-A; $n = 30$) compared to client-centered therapy (CCT; $n = 31$). Both treatments consisted of fourteen 60-90 minute sessions. The Child PTSD Symptom Scale-Interview (CPSS-I) was used to diagnosis PTSD and to assess frequency of insomnia and nightmares; it was completed at baseline, post-treatment, and at 6- and 12- months follow-ups. The Children's Global Assessment Scale (CGAS) was used to assess general functioning. The CPSS-I and CGAS were administered by independent evaluators who were blind to participants' treatment condition.

Results: General Linear Model (GLM) repeated measures analyses were conducted on insomnia and nightmare symptoms with treatment condition (PE-A/CCT) as the between subjects variable. No significant time by condition interactions were found; however, statistically and clinically significant effects of time ($p < .001$) were found for frequency of nightmares and insomnia, with symptoms decreasing from baseline to post-treatment. Both nightmare and insomnia symptoms significantly predicted general functioning and accounted for 20.3%-28.9% of the variance in this measure over time.

Conclusion: Both treatments produced significant improvements in sleep-related PTSD symptoms; however, these sleep symptoms continued to impair general functioning over time.

Support (If Any): This study was supported by the National Institute of Mental Health (R01MH074505) PI: Edna Foa.

0781

MILITARY SEXUAL TRAUMA AND INSOMNIA IN OEF/OIF/OND VETERANS

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Introduction: Military Sexual Trauma (MST) affects a significant proportion of Veterans and is associated with increased rates and greater severity of psychiatric symptoms (e.g., PTSD, depression, alcohol misuse). Despite a growing knowledge-base of MST, there is currently little information about sleep functioning in MST populations. Present study aims included examining prevalence and severity of insomnia, impact

of insomnia on other psychological domains, and the role of resiliency in Veterans with MST.

Methods: Participants were 917 first-encounter Veterans (Age = 33.57 ± 8.10 ; 84.3% male) completing a routine battery of self-report questionnaires including measures assessing sleep (ISI), PTSD (PCL), depression (PHQ), alcohol (AUDIT-C), and resiliency (CD-RISC-10). Roughly 8% ($n = 74$) screened positive for MST.

Results: Of Veterans positive for MST, 28% reported no insomnia, 24% mild, 28% moderate, and 19% severe. Veterans positive for MST scored significantly higher on the ISI ($M = 13.4 \pm 8.1$) than veterans negative for MST ($M = 10.8 \pm 7.6$, $p < .01$, $d = .3$). Within the MST group, Veterans with assault histories scored significantly higher on the ISI ($M = 16.5 \pm 8.3$) than those with unwanted sexual advances but no assault histories ($M = 12.3 \pm 7.9$, $p < .05$, $d = .5$). Within the MST group, increased insomnia associated with higher PCL ($p < .001$, $\beta = .8$), PHQ ($p < .001$, $\beta = .7$), and the AUDIT-C ($p < .05$, $\beta = .2$); findings were consistent for both sexual assault and unwanted advances. Higher resiliency in MST was significantly associated with lower insomnia, $p < .001$ ($\beta = -.5$).

Conclusion: 72% of Veterans positive for MST have clinically significant insomnia symptoms. In the context of MST, more severe insomnia is associated with higher levels of PTSD, depression, and alcohol misuse. Resiliency may moderate insomnia, serving as a protective function in Veterans with MST. Overall, the present study highlights the importance of assessing sleep in MST and supports future investigations of how sleep problems may exacerbate symptoms of trauma and frequently co-occurring conditions.

Support (If Any): Center of Excellence for Stress and Mental Health.

0782

LIFETIME TRAUMA HISTORY IS ASSOCIATED WITH INCREASED SIGMA ACTIVITY AMONG COMBAT EXPOSED MILITARY VETERANS

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Introduction: We have previously proposed that sigma activity [12-16 Hz range] during sleep may reflect a marker of psychological resilience among combat-exposed service members. The present study evaluated the effects of early-life trauma exposure, later-life trauma exposure, and past-month PTSD symptom severity on NREM sigma activity.

Methods: Forty-six OEF/OIF/OND veterans (29.33 ± 5.82 years, 78.26% men) were drawn from a parent study. The Trauma History Questionnaire (THQ) was administered to group participants into low or high categories based on a median split for their early-life (THQ18 [i.e., < 6 or ≥ 6 discrete traumatic events]) trauma exposure. Final groups consisted of: Low THQ18 ($n = 10$); High THQ18 ($n = 13$); Low THQ18 ($n = 8$); and High THQ18 ($n = 15$). ANOVAs were calculated to analyze group differences on sigma activity. Regression analyses were calculated to examine the relations between exposure categories and Sigma activity, after adjusting for past-month PTSD symptoms as measured by the Clinician Administered PTSD Scale.

Results: Groups differed in sigma power at a trend-level ($F[3,42] = 1.73$, $p = .175$), with the largest difference occurring between the lowest trauma group and the highest trauma group during NREM ($d = 1.10$). Regression analyses indicated that the relation between exposure groups and sigma activity was significant ($\beta = 0.30$, $t = 2.15$; $R^2 = 0.09$, $p < .05$), and was fully mediated by past-month PTSD symptom severity ($\beta = 0.23$, $t = 1.48$; $R^2 = 0.13$, $p = .148$).

Conclusion: The cumulative load of traumatic events across the lifespan, rather than when the events occurred, is associated with increased sigma power during NREM sleep. Previous research has shown that NREM sigma activity promotes neuroplastic changes in hippocampus-dependent declarative memory. Collectively, these results suggest that

the cumulative load of traumatic events, by way of current PTSD symptom severity, may influence these processes during NREM sleep.

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0783

RELATION OF NON-RAPID EYE MOVEMENT BETA AND DELTA ACTIVITY TO LIFETIME POSTTRAUMATIC STRESS DISORDER AMONG MILITARY COUPLES

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Introduction: Sleep disturbances are a hallmark symptom of post-traumatic stress disorder (PTSD), and are particularly prevalent among service-members returning from Operation Enduring Freedom, Operation Iraqi Freedom, or Operation New Dawn (OEF/OIF/OND). Less is known, however, about the relationship between PTSD and sleep disturbances in military spouses. Consistent with research and theory regarding the etiological role of hyperarousal in insomnia, we hypothesized that higher levels of PTSD symptoms, in both service-members and spouses, would be associated with increased central arousal during non-rapid eye movement (NREM) sleep, as measured by heightened beta activity and decreased delta activity.

Methods: Participants were married or cohabitating adults (N = 41; Mean Age = 31.0 ± 5.0; 24 Veterans); at least one of whom had served in support of OEF/OIF/OND. Participants underwent 2 nights of in-home polysomnography (PSG) recordings. Lifetime and past month PTSD scores were assessed using the Clinician Administered PTSD Scale (CAPS). Linear regressions were used to assess the relationship between Lifetime PTSD and relative delta and beta activity with age, sex, and past month PTSD as covariates.

Results: Mean lifetime CAPS scores were 53.54 ± 21.68 for the total sample; service-members and spouses did not differ significantly in lifetime PTSD. For past month PTSD, service-members had higher CAPS scores (37.50 ± 16.46) than spouses (17.82 ± 11.89). Lifetime PTSD was significantly associated with higher beta activity during NREM ($R^2 = .41$; $F[5,35] = 4.80$; $p = .001$), but was not associated with delta activity after adjustment for covariates. Past month PTSD was not associated with either delta or beta activity.

Conclusion: The current study is the first to examine high- and low-frequency quantitative EEG activity among military couples. Lifetime exposure to PTSD is associated with hyperarousal, indexed by increased NREM beta activity, in service-members and their spouses. Future research should examine the effect of sleep disruption on relationship dynamics within military couples.

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0784

INCREASED FRONTAL SOURCE-MODELED WAKING EEG THETA ACTIVITY IN INDIVIDUALS WITH REPORTED SLEEP DISTURBANCE

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Introduction: Prior research has demonstrated increases in low-frequency (< 9 Hz) activity in the waking EEG across extended wakefulness, predominantly in the theta range (4-8 Hz) and in frontal regions. Changes in waking EEG theta have been correlated with sleep slow-wave activity, also predominantly frontal in scalp topography, suggest-

ing that waking theta activity is related to homeostatic sleep processes and thus is likely impacted by sleep disturbance. This analysis on an archival dataset examined whether individuals with higher self-reported sleep disturbance showed increases in waking EEG theta activity relative to individuals with lower reported sleep disturbance.

Methods: Data from 313 young adults (68% female; mean age 19.2 ± 2.0 years), approximately half with a history of major depression or dysthymia (N = 150), were included for analysis. Participants underwent 4 laboratory sessions within a 2 week period. At each session, the Beck Depression Inventory (BDI-II) was completed, along with 2 recordings of eyes-closed waking 64-channel EEG. Participants were stratified into sleep disturbance subgroups based on average score for the single sleep item of the BDI-II across the 4 sessions. Waking EEG data were processed semi-automatically to remove artifacts, source-modeled using sLORETA, and averaged across the 8 recordings. Between-group comparisons based on sleep-disturbance stratification were conducted using 2-tailed unpaired t-tests.

Results: Participants with higher self-reported sleep disturbance demonstrated significantly greater waking EEG theta activity in multiple frontal cortical structures compared to individuals with lower reported sleep disturbance. This pattern was most robust for individuals with current major depression. The results were not influenced by type of sleep disturbance (i.e. insomnia vs. hypersomnia).

Conclusion: These results extend prior research on waking EEG theta activity and sleep-related processes, demonstrating effects of sleep disturbance on waking theta using a single item on the BDI-II. Further research is indicated to explore the mechanisms and clinical significance of these findings.

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0785

AN EXPLORATORY FACTOR ANALYSIS OF SYMPTOMS IN VETERANS AND MILITARY PERSONNEL WITH CO-MORBID PTSD AND POOR SLEEP QUALITY

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Introduction: Veterans of recent military conflicts diagnosed with PTSD experience high levels of co-morbid depression and poor sleep quality. Sleep-focused interventions are needed that take into consideration the unique clinical presentation of this population. However, research examining the relative contribution of depression and trauma symptoms to sleep disturbance in this ever-increasing population is largely absent. The purpose of the current study was to explore the latent factor structure of trauma and depression symptoms in recently deployed Veterans with co-morbid PTSD and poor sleep quality.

Methods: Participants were Veterans and active duty military personnel (N = 520; 82.1% male) with PTSD and poor sleep quality who served since September 11, 2011, deployed 1 or 2 times (81.5%), and were aged 35.8 years (SD = 9.3). PTSD diagnosis was established using the Structured Clinical Interview for DSM-V and poor sleep quality was defined as a Pittsburgh Sleep Quality Index score exceeding 5. Exploratory factor analysis was used to determine the underlying factor structure of the combined Beck Depression Inventory-II and Davidson Trauma Scale items, with sleep items removed.

Results: A four-factor solution best fit the data and explained 55% of the variance in symptoms among Veterans and active duty military personnel with co-morbid poor sleep quality and PTSD. Symptoms that are unique to PTSD, such as re-experiencing, avoidance, and hyperarousal,

explained the majority of variance (38.1%), followed by poor self-perception, sadness and suicidal ideation (9.5%), somatic manifestations of depression (4.5%) and anhedonia (3.3%).

Conclusion: Ongoing efforts to develop trauma-specific interventions should consider the relative prominence of mental health symptoms in this population, and the findings of this analysis suggest that trauma symptoms may be the most important to consider when designing interventions targeting poor sleep quality. Confirmatory factor analysis is needed to support these findings.

0786

THE RELATIONSHIP BETWEEN SLEEP QUALITY, ANGER AND AGGRESSION IN PTSD

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Introduction: An emerging body of research is examining the role of sleep in regulating negative emotions such as fear and anger. Sleep disturbance, anger and aggression are common complaints in veterans and active duty military personnel diagnosed with PTSD, however, limited research has examined associations between these variables. In the current study, we examined these relationships in a large sample of post-9/11 Veterans and active duty personnel.

Methods: This retrospective study included 2166 active duty personnel and veterans who served since September 11, 2011 (mean = 37.3 years, 79.6% male, 11.3% active duty), 31% with current PTSD, as assessed with the Structured Clinical Interview for DSM-IV. Participants provided ratings of sleep quality using the Pittsburgh Sleep Quality Index (PSQI) and ratings of depressive symptom severity (Beck Depression Inventory II, BDI-II), PTSD symptom severity (Davidson Trauma Scale, DTS), and two previously validated factors based on the Symptom Checklist- 90 hostility subscale: difficulty managing anger and aggressive impulses or urges (Elbogen et al., 2010). Regression models were used to examine the relationships among sleep quality, PTSD symptom severity, depression, and anger and aggressive impulses or urges.

Results: Among participants with current PTSD, a model including age, gender, BDI-II total, DTS total and PSQI total explained 24% of the variance in aggressive impulses or urges ($F = 42.19$, $P < 0.001$). All predictor variables in the model were significantly associated with aggressive impulses ($P < 0.01$). PSQI total was not associated with difficulty managing anger in veterans with current PTSD. In participants without current PTSD, PSQI total was not a significant predictor of difficulty managing anger nor aggressive impulses or urges ($P > 0.01$).

Conclusion: Our results suggest that aggressive impulses or urges may be related to poor sleep quality in recently deployed male Veterans and active duty personnel with PTSD, providing further support for the role of sleep in the emotional dysregulation of this disorder. Clinically, the current results underscore the need to assess and treat sleep disturbances in active duty personnel and Veterans diagnosed with PTSD.

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0787

DO VETERANS WHO RECEIVE LESS SLEEP THE NIGHT BEFORE MENTAL HEALTH APPOINTMENTS HAVE WORSE ASSESSMENT AND THERAPY OUTCOMES?

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Introduction: Few studies have examined how sleep and attention influence psychiatric assessment and psychotherapy outcomes. Based on what we know about negative recall bias, we hypothesized that poor sleep the night before a symptom assessment and worse psychomotor vigilance the day of the assessment would be associated with a worse post traumatic stress disorder (PTSD) symptom assessment. We also hypothesized that poor sleep the night before cognitive behavioral therapy (CBT) for PTSD and less sustained attention before therapy would correspond to worse therapy response.

Methods: Thirty-one Veterans (2 females, M age = 54.39, SD = 13.55) enrolled in CBT, prolonged exposure or cognitive processing therapy, with a VA-trained, certified provider completed a daily sleep diary and Psychomotor Vigilance Task (PVT) at their baseline assessment and monthly prior to their therapy session. Reliable, psychiatric raters administered the gold standard Clinician Administered PTSD Scale (CAPS) at baseline at 30-days post-treatment. Data were analyzed with bivariate correlations and repeated measures ANOVA.

Results: Results indicated that more severe PTSD symptoms were associated with worse sleep quality ($r = -.39$, $p < .05$) and less total sleep time ($r = -.44$, $p < .05$) the night before assessment, fewer feelings of being refreshed the morning of assessment ($r = .48$, $p < .05$) and lower mean reciprocal response time ($r = -.43$, $p < .05$) on the PVT. When the CAPS sleep items were removed, all results remained except the correlation between sleep quality and PTSD severity ($r = -.31$, $p > .10$). CBT response was not associated with the amount of sleep received the night before therapy or average scores on any PVT indices immediately prior to therapy.

Conclusion: Veterans reporting more severe PTSD symptoms had less total sleep time the night before the assessment. They also felt less refreshed that morning and had worse response times. These data indicate that psychiatric assessment results might be affected by the amount of sleep received the night before the appointment. Neither previous night's sleep nor same-day PVT performance were associated with therapy response, potentially indicating that successful CBT for PTSD may not require sustained attention.

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0788

PRazosin INCREASES BRAIN GLUCOSE METABOLISM IN REGIONS INVOLVED IN FEAR EXTINCTION LEARNING AND MEMORY DURING REM SLEEP IN COMBAT EXPOSED VETERANS WITH PTSD

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Introduction: Prazosin, a noradrenergic alpha-1 antagonist, has been shown to effectively reduce nightmares comorbid with posttraumatic stress disorder (PTSD). The study explored the effects of prazosin compared to placebo on regional cerebral metabolic rate of glucose (rCMRglc) during REM sleep and relative to wakefulness in combat-exposed Veterans with PTSD.

Methods: Nineteen combat Veterans with PTSD were randomized to prazosin (M age = 27.0±5.6 years old; 3 women) and seventeen veterans were randomized to placebo (M age = 30.2±5.6; 5 women) for an 8-week randomized controlled trial. All completed in-lab PSG and 18F-FDG positron emission tomography (PET) studies during wakefulness and REM sleep at baseline, and again after treatment. State × Time interaction analyses were performed using SPM 8 to determine the changes in wakefulness and REM sleep pre- to post-treatment. Pre- to post-treatment changes in rCMRglc during wakefulness and REM sleep were evaluated using SPM8.

Results: Complete, high-quality PET data was available for 7 Veterans randomized to prazosin and 12 Veterans randomized to placebo. No significant State × Time interactions were detected in the placebo group. Post-treatment, prazosin was associated with a larger increase in relative rCMRglc from wakefulness to REM sleep compared to pre-treatment in two separate clusters. The first clusters included 2659 voxels (x, y, z = -4, 4, -2), and encompassed the putamen and caudate, subgenual cingulate cortex, hypothalamus, hippocampus, entorhinal and parahippocampal gyri, and lateral caudal parietal cortex (Z = 3.52, p = 0.021). The second cluster included 1933 voxels (x, y, z = -60, -12, -8), and comprised the left inferior frontal cortices, post-central cortex, and superior temporal gyrus (Z = 3.38, p = 0.045).

Conclusion: These preliminary findings suggest that prazosin increases brain glucose metabolism in brain regions known to be involved in fear extinction learning and memory during REM sleep relative to wakefulness.

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0789

COMPARATIVE META-ANALYSIS OF PRAZOSIN AND IMAGERY REHEARSAL THERAPY FOR NIGHTMARES, SLEEP DISTURBANCE AND POST-TRAUMATIC STRESS

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Introduction: Prazosin is the recommended treatment for post-traumatic stress disorder-associated nightmares, whereas imagery rehearsal therapy (IRT) is the recommended treatment for nightmare disorder. In this meta-analysis, we compare the short-term efficacy of prazosin

vs. IRT on nightmares, sleep quality and post-traumatic stress disorder symptoms (PTSD-S).

Methods: Reference databases were searched for randomized controlled trials using IRT or prazosin for nightmares, sleep disturbance, and/or PTSD-S. Effect sizes were calculated by subtracting the mean post-test score in the control group from the mean post-test score in the treatment group, and dividing the result by the pooled standard deviation of both groups. Mixed effects models were performed to evaluate effects of treatment characteristics, as well as sample characteristics (veteran vs. civilian) on treatment efficacy.

Results: Four studies used prazosin, 10 used IRT alone or in combination with another psychological treatment and 1 included a group of subjects receiving prazosin and another group receiving IRT. Overall effect sizes of both treatments were of moderate magnitude for nightmare frequency, for sleep quality, and for PTSD-S (p < .01). Psychological vs. pharmacological treatment did not affect the effect sizes (nightmare frequency, p = .79; sleep quality, p = .65; PTSD-S, p = .52). IRT combined with CBT for insomnia showed more improvement in sleep quality than samples treated with prazosin (p = .03), IRT alone (p = .03), or IRT combined with another psychological intervention, (p < .01). Veteran vs. civilian population had no significant effect on nightmare frequency, (p = .54), sleep quality, (p = .17), or PTSD-S, (p = .15).

Conclusion: Although IRT interventions and prazosin yield comparable acute effects for the treatment of nightmares, adding CBT for insomnia to IRT seems to enhance treatment outcomes pertaining to sleep quality and PTSD-S. More randomized clinical trials, with long-term follow-up, are warranted.

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0790

LUCID DREAMING AND THE TREATMENT OF NIGHTMARES IN OEF/OIF/OND VETERANS WITH PTSD

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Introduction: Frequent, distressing nightmares are prevalent among Veterans with PTSD. Cognitive-behavioral treatments for posttraumatic nightmares, under the umbrella title Imagery Rehearsal (IR), have received increasing attention. A core objective of IR is increasing feelings of mastery over negative dream content. Lucid dreaming is the reflective awareness and metacognitive monitoring of an ongoing dream; it has not been studied in posttraumatic nightmares. We hypothesized that lucid dreaming would be related to baseline sleep and other posttraumatic symptomatology, and that lucid dreaming experiences would increase with IR.

Methods: Fourteen OEF/OIF/OND Veterans with PTSD and recurrent nightmares participating in an ongoing RCT comparing CBT-insomnia (CBT-I) alone and CBT-I+IR have to date completed the Lucid Dreaming subscale of the Iowa Sleep Experiences Scale; this assesses 3 aspects of lucid dreaming: dream awareness, control of dream content, and purposeful waking. Other measures included the Nightmare Frequency Questionnaire (NFQ), the Nightmare Distress Questionnaire (NDQ), the Pittsburgh Sleep Quality Inventory (PSQI), and the PTSD Checklist-Military (PCL-M). Pre- and post-treatment data were obtained.

Results: At pre-treatment, lucid dreaming was uncommon (median for awareness and waking = several times a year; for control of dream content = never) and was not significantly related to fewer nightmares, less nightmare-related distress, severity of PTSD, or sleep symptomatology. Only the CBT-I+IR group significantly increased their subjective control of nightmare content (t(7) = 2.4, p < .05). Furthermore, CBT-I+IR compared to CBT-I alone resulted in greater changes in control of nightmare content and purposeful waking (t(12) = 2.6 and t(12) = 2.4,

respectively, $p < .05$). Although not significant likely due to the small n , change in Veterans' ability to control nightmare content was also correlated with reduction in post-treatment nightmare frequency ($r = .62$) in the CBT-I+IR group.

Conclusion: Lucidity of dreams appears to be an important factor in the treatment by CBT-I+IR of recurrent nightmares in PTSD. Implications for research on nightmare phenomenology and treatment are discussed.

Support (If Any): Department of Defense.

0791

POSITIVE PTSD PSYCHOTHERAPY OUTCOMES ARE ASSOCIATED WITH MORE SPONTANEOUS AROUSALS

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Introduction: Untreated sleep disorders cause sleep fragmentation, and the daytime effects of sleep fragmentation mimic the effects of chronic partial sleep deprivation. Since sleep deprivation is associated with avoidance of effortful tasks and cognitive performance deficits, we hypothesized that Veterans with worse sleep would have worse PTSD psychotherapy response than Veterans with better sleep.

Methods: Thirty one Veterans (2 females, M age = 54.39, SD = 13.55) with PTSD from trauma that occurred while deployed in a combat zone engaged in either Cognitive Processing Therapy or Prolonged Exposure Therapy for PTSD. These therapies were administered by VA mental health providers, who had received a VA certification of training competency in each respective modality. Treatment outcome was assessed by the gold-standard Clinician Assessment for PTSD Scale at baseline and 30-days after the conclusion of therapy. Daily sleep diaries were administered at baseline, and in-home ambulatory polysomnography was administered 30-days post-treatment.

Results: Repeated measures ANOVA demonstrated a large interaction effect between change in CAPS score and total number of spontaneous arousals [Greenhouse-Geisser $F(1,29) = 9.23$, $p = .005$, $\eta^2 = .25$]. There was also a medium to large interaction effect between change in CAPS scores and morning feelings of being refreshed [Greenhouse-Geisser $F(1,30) = 3.15$, $p = .09$, $\eta^2 = .10$]. For both findings, greater PTSD symptom reduction was associated with more severe sleep symptoms. There were no significant interaction effects for sleep disordered breathing or insomnia indices.

Conclusion: Opposite to our hypothesis, Veterans experiencing unrefreshing sleep had better PTSD treatment outcomes. One possible explanation is that unrefreshing sleep maybe a salient motivator for PTSD psychotherapy engagement. Neither insomnia nor sleep disordered breathing indices were associated with treatment outcome. These preliminary findings suggest that PTSD psychotherapy should not be delayed for the treatment of sleep disorders.

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0792

EXAMINING THE EFFICACY OF ADDING SLEEP-SPECIFIC THERAPIES TO AN EMPIRICALLY VALIDATED TRAUMA TREATMENT IN VETERANS WITH PTSD

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Introduction: PTSD affects 20-37% of recently deployed veterans, and is associated with significant impairments in life functioning. Empirically validated therapies exist (e.g., Prolonged Exposure; PE); however, they do not effectively treat sleep symptoms. Here, we examine how combining treatments for nightmares (Imagery Rehearsal Therapy: IRT) and insomnia (Cognitive Behavioral Therapy for Insomnia: CBT-I) may increase efficacy of PTSD treatment.

Methods: Participants were OEF/OIF/OND Veterans with PTSD, chronic insomnia and recurring nightmares. Participants were randomized to PE treatment followed by 12 weeks of supportive care therapy (SCT), or PE followed by 12 weeks of IRT/CBT-I. Twelve participants completed the entire 18-week treatment. Analyses examined differences between groups (IRT/CBT-I vs. SCT) on self-reported sleep (ISI, PSQI, PSQI-Addendum), PTSD (PCL), and depression (PHQ) measures, clinician-administered PTSD ratings (CAPS), and daily diaries (SE, TST).

Results: Groups were similar following PE. At the end of IRT, there were no significant group differences for frequency or intensity of nightmares. The IRT group, however, reported half as many total weekly nightmares ($M = 2.2 \pm 2.5$) compared to SCT ($M = 5.3 \pm 7.3$), $d = .6$. The full sleep treatment (IRT/CBT-I) significantly improved ratings on sleep questionnaires ($p = .02$): ISI (IRT/CBT-I: $M = 6.8 \pm 5.9$ vs. SCT: $M = 18.2 \pm 5.9$, $d = 2.1$), PSQI (IRT/CBT-I: $M = 6.4 \pm 3.4$ vs. SCT: $M = 14.4 \pm 2.9$, $d = 2.8$) and PSQI-Addendum (IRT/CBT-I: $M = 3.6 \pm 3.6$ vs. SCT: $M = 11.0 \pm 2.9$, $d = 2.5$). Diary data also showed significant effects of IRT/CBT-I ($p = .003$), with significant improvements in SE (IRT/CBT-I: $M = 93.8 \pm 3.1$ vs. SCT: $M = 77.6 \pm 5.8$, $d = 3.3$), but not TST (IRT/CBT-I: $M = 382.5 \pm 30.3$ vs. SCT: $M = 358.4 \pm 75.6$, $d = .5$). Despite non-significant findings for PTSD and depression, IRT/CBT-I ended in mild ranges for depression (PHQ = 5.8 ± 5.9) and PTSD (CAPS = 31.8 ± 21.0), while SCT ended in moderate ranges for depression (PHQ = 12.2 ± 6.4) and PTSD (CAPS = 54.6 ± 22.9), both $d = 1.2$.

Conclusion: This was the first study combining sleep treatments with PE, examining benefits on clinical symptoms in Veterans. Despite sample size and power limitations, findings suggest sleep treatments improve sleep and may reduce daytime PTSD symptoms and depression. This study supports future investigations of new combinations of therapies to improve PTSD outcomes.

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0793

PTSD AND SLEEP APNEA: OBJECTIVE ASSESSMENT OF PTSD SYMPTOM IMPROVEMENT WITH CPAP THERAPY IN VETERANS WITH OSA

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Introduction: About 26-31% of US Veterans suffer from post-traumatic stress disorder (PTSD). Prevalence of obstructive sleep apnea (OSA) is three times higher among Veterans with PTSD than in general population. Some previous retrospective studies reported subjective improve-

ment in PTSD symptoms with CPAP therapy, but no objective validation tools were used. We performed a prospective study on Veterans with PTSD and OSA with objective measurement of PTSD symptoms by PTSD check list (PCL) questionnaire to see if their PTSD symptoms improve with CPAP therapy.

Methods: The participants were male Veterans ($n = 34$) with PTSD who have been newly diagnosed with OSA by polysomnography. The diagnostic polysomnographies were reviewed to extract data including age, BMI, total and REM apnea hypopnea index (AHI) and REM sleep percentage. Each patient filled out a PCL questionnaire and reported Epworth sleepiness score (ESS) and the average number of nightmares (per week) before and 3 months after CPAP therapy. Repeated-measures t-tests were performed, comparing mean nightmare frequency, ESS and PCL score before and after treatment. Multiple linear regression analysis was performed to identify potential factors predicting improvement in total PCL score with CPAP.

Results: CPAP therapy decreased the weekly mean nightmare frequency ($P = 0.001$), ESS ($p = 0.002$) and the total mean PCL score ($p = 0.041$). Out of 17 factors in PCL, 3 factors describing memory and concentration ($p = 0.05$), panic symptoms (0.04) and overall sleep quality (0.002) improved significantly after CPAP. Reduced PCL score was best predicted by increased REM AHI and decreased REM sleep percentage ($R^2 = 0.67$, $p < 0.001$) at baseline polysomnography.

Conclusion: In Veterans with PTSD and OSA, CPAP treatment is associated with improvement in nightmare frequency, daytime sleepiness, panic symptoms, memory and concentration and overall sleep quality. Presence of higher REM AHI and lower REM sleep percentage at baseline is associated with greater decrease in PCL score with CPAP.

0794

POSITIVE AIRWAY PRESSURE ADHERENCE IN MILITARY PATIENTS WITH PTSD

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Introduction: It is well known that patients with post-traumatic stress disorder (PTSD) have fragmented and disrupted sleep. Veterans and active duty personnel recovering from combat related stress often suffer from nightmares and endorse poor sleep for years after returning from the battlefield. Recent research suggests these patients suffer a higher than anticipated prevalence of obstructive sleep apnea (OSA), but scant research addresses how well these patients adhere to positive airway pressure therapy (PAP-T).

Methods: We present an analysis of the current medical literature regarding the use of PAP-T in veteran and active duty patients diagnosed with OSA and PTSD. We completed a systematic search of bibliographic databases including MEDLINE, EMBASE, the Cochrane Database of Systematic Reviews, and CINAHL using the following search terms: "obstructive sleep apnea" and "post-traumatic stress disorder" and "positive airway pressure" or "continuous positive airway pressure (CPAP)."

Results: Service members with OSA and PTSD have significantly lower positive airway pressure adherence rates compared to other veterans without PTSD. Compliance rates varied between 41% to 61% in veterans diagnosed with PTSD and OSA, whereas, rates of compliance in veterans without PTSD have ranged between 70% and 76%. We found only 7 peer reviewed articles addressing the topic of positive airway pressure adherence in the rapidly expanding active duty and veteran population diagnosed with PTSD.

Conclusion: OSA and PTSD are among the most common co-occurring conditions diagnosed in American war veterans, active duty and retired. Currently there is little research exploring the efficacy of treat-

ments in patients suffering from both PTSD and OSA. This presentation highlights the challenges in the use of PAP-T in veteran and active duty populations diagnosed with post-traumatic stress disorder and offers recommendations for further research on this topic.

0795

THE EEG DURING SLEEP IS A WINDOW TO THE MIND: ANALYSIS OF BRAIN RECURRENCE (ABR) OF THE EEG DURING SLEEP ACCURATELY IDENTIFIES SUBJECTS WITH MENTAL HEALTH SYMPTOMS

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Introduction: ABR is a novel, nonlinear method of algorithmically quantifying the degree of non-randomness (complexity) within a moving timeframe in an EEG signal, producing delocalized variables that track with traditional stage-related concepts of sleep depth and fragmentation. We postulated that ABR could accurately identify a signature in the EEG during sleep specific for the presence of mental health symptoms.

Methods: The study sample comprised subjects drawn from the Sleep Heart Health Study, for whom depression symptomatology had been ascertained, based on the Mental Health Index (MHI-5). Subjects with sleep apnea and significant cardiovascular disease were excluded. MHI-5 scores were scaled to disperse values between 0 and 100, higher values indicating better mental health. From eligible subjects, we selected 34 subjects with MHI-5 scores > 50 , and 34 subjects matched for sex, BMI age, and race with MHI-5 scores < 50 . The EEGs were sampled at 125 Hz and interpolated to 500 Hz for analysis. ABR markers were analyzed using linear discriminant analysis to identify combinations of the markers that reliably classified individual subjects into low versus high MHI-5 scores. The accuracy of classification was assessed using area under the receiver operating characteristic curve (AUROC).

Results: The ABR-produced EEG biomarker accurately classified low versus high MHI-5 scores within the cohort analysis sample ($N = 68$) (AUROC = 0.82). Subgroup analysis based on elimination of central MHI-5 scores improved classification accuracy. When only the 20 highest and 20 lowest MHI-5 scores were used, AUROC was 0.89; using the 10 highest and 10 lowest MHI-5 scores, AUROC was 1.00. Biomarker values for individual subjects correlated ($P < 0.05$) with MHI-5 score ($r = 0.36, 0.54, 0.69$ for $N = 68, 40, 20$, respectively).

Conclusion: ABR of the EEG during sleep yielded an EEG biomarker function that classified subjects into one of two classes (low versus high MHI-5 scores) at a relatively high level of discriminative power.

0796

SLEEP MODERATES EFFECTS OF A DEPRESSIVE EPISODE ON RESPONSE BIAS TO EMOTIONAL EYES

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Introduction: Response bias was a tendency to say "yes" or "no" in distinguishing learnt materials from new information. Depressive individuals, even remitted, were reported to be biased in recalling negative experience. While poor sleep was shown to be associated with depressed mood, its role in emotion-modulated cognition (including response bias towards emotional stimuli) in depressed individuals remained to be determined.

Methods: A community sample ($n = 81$, 32 males, aged 17-25, non-medicated) was recruited and interviewed according to the structural-clinical-interview for DSM-IV disorders. Sixteen participants reported a depressive episode (depressive-episode group) in the lifetime, and the rest formed the control-group. Both groups completed a five-day sleep-log and emotional recognition memory task of positive, neutral and negative eyes. There was a learning- and testing-phase, separated by either a 90-minute polysomnography-monitored nap or wakefulness. Response bias (c') was calculated following signal detection theory, with a negative c' representing tendency to say "yes", and positive c' for "no".

Results: The depressive-episode and control-group were matched on demographics and sleep duration ($ps > .05$). A factorial design with two between-subject factors (depressive-episode and nap-condition) revealed a significant main effect of depressive-episode on positive eyes c' , $F(1,72) = 5.74$, $p = .019$, indicating more negative c' towards positive eyes. Depressive-episode interacted with nap-condition on c' of positive, $F(1,72) = 4.432$, $p = .039$, and negative eyes, $F(1,72) = 5.895$, $p = .018$. Post-hoc analyses (Mann-Whitney U test) showed that among the depressive-episode group, napped individuals had significantly more negative c' on positive ($p = .049$) and negative eyes ($p = .026$). Among controls, there were no differences between the napped and wake individuals ($ps > .05$).

Conclusion: Sleep was found to moderate the effects of depressive episode on response bias in emotionally-charged eyes: following a nap, individuals with depressive episode had a higher tendency to say "yes" to both positive and negative eyes, suggesting that sleep may facilitate recognition of both positive and negative information in individuals with depressive episode.

0797

MOOD-CONGRUENT BIAS IN AFFECTIVE GO/NO-GO TASK AMONG DEPRESSED INDIVIDUALS WITH SELF-IMPOSED SLEEP RESTRICTION

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Introduction: Sleep deprivation was shown to lead to cognitive processing biases toward negative information in healthy population. Such biases have also been reported in depressed individuals. This study investigated the interaction between sleep and depressive mood on affective biases.

Methods: Sixty-six young adults (Aged 17-25, 62.1% female) completed a 5-day sleep diary before experiment. Eighteen of them (27.3%) habitually slept for 4-6.5 hours per night and formed the "sleep-restricted group," while 48 participants slept for > 6.5 hours and formed the "control group." Participants were further classified into the depressed group (scored > 4 in the depression subscale of 21-item Depression Anxiety Stress Scale), with 27.8% and 30.4% depressed participants in the sleep-restricted and control group, respectively. Affective bias was evaluated by an Affective Go/No-Go Task with happy, fearful and neutral faces as targets. Omission errors were compared with two-way analyses of variance with sleep restriction and depressive mood as between-group variables.

Results: There were no significant group differences in age, sex, body mass index and depressive symptoms, $ps > .05$. For happy faces, there were significant main effects of sleep restriction, $F(1,58) = 8.679$, $p = .005$, and depressive mood, $F(1,58) = 6.571$, $p = .013$, in which sleep-restricted and depressed individuals made more omission errors than control and non-depressed individuals, respectively. Also, a significant interaction effect between sleep restriction and depressive mood was observed, indicating disproportionately more errors in participants, who were both sleep-restricted and depressed, $F(1,58) = 9.843$, $p = .003$. No significant effects were found for other faces, $ps > .05$.

Conclusion: Self-imposed sleep restriction and depressed mood were both found to relate to increased omission errors specifically to happy, but not fearful or neutral faces, and such effects increased disproportionately when compounded together. Our findings shed light on the importance of sleep in understanding emotion-modulated cognitive functioning among depressed individuals.

0798

DEPRESSION, INSOMNIA AND NICOTINE: OVERLAPPING IMPEDIMENTS TO SLEEP IN A NATIONAL SAMPLE OF COLLEGE STUDENTS

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Introduction: College students ages 18-24 are vulnerable to a myriad of health challenges including the first onset of depression and initial tobacco use, both of which disrupt sleep architecture. In order to better understand these relationships, we evaluated the negative impact of nicotine on sleep health measures in both depressed and non-depressed students in a large national sample.

Methods: We analyzed 82,222 responses (63% female, 74% white, 83% undergraduate) from the 2009 American College Health Association National College Health Assessment for the following sleep measures: insomnia diagnosis, sleep-related impediments to academic performance, excessive daytime sleepiness, and problems with sleep timing and maintenance. Differences in sleep health were analyzed by depression diagnosis (10%) and daily tobacco use (8%).

Results: Depressed students were twice as likely to be daily tobacco users as compared to non-depressed students. For all measures, daily tobacco users reported more sleep problems than both occasional and non-tobacco users ($F(2,84244) > 147$, $p < .001$). Daily tobacco use increased the odds of reporting sleep-related academic problems by 1.85 and the odds of being diagnosed with insomnia by 2.66. Among students with depression, daily tobacco use exacerbated sleep problems, particularly with sleep timing and maintenance. Daily tobacco users with depression had more binge drinking and sleep problems than did depressed non-tobacco users.

Conclusion: These findings provide useful information for health professionals in aiding college aged individuals in the management of depression and improvement of sleep quality.

0799

ASSOCIATION BETWEEN SLEEP DISORDERED BREATHING AND DEPRESSIVE SYMPTOMS AMONG COMMUNITY-DWELLING OLDER MEN

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Introduction: Depression and sleep disordered breathing (SDB) are common co-morbid conditions. Our aim was to determine the association between the presence of SDB and depressive symptoms in community-dwelling older men.

Methods: We assessed depressive symptoms using a Geriatric Depression Scale (GDS) and SDB using unattended overnight polysomnography in 2,895 men aged 67 years and older enrolled in the Outcomes of Sleep Disorders in Older Men (MrOS Sleep) study. SDB was defined as AHI > 5 (mild), AHI > 15 (moderate) and AHI > 30 (severe), Central sleep apnea (CSA) was defined as Central Apnea Index (CAI) > 5 vs. < 5, and night-time hypoxemia (percent time SaO₂ < 90%) was expressed as quartiles. Depressive symptoms were categorized as 0-2 (normal), 3-5 (some depressive symptoms) and 6-15 (depressed). We used multinomial logistic regression to examine cross-sectional associations between measures of SDB and categories of depressive symptoms.

Results: 998 (34.5%), 483 (16.7%) and 284 (9.8%) of men had mild, moderate and severe SDB respectively. 187 (6.5%) of men were depressed, and 513 (17.7%) of men had some depressive symptoms. Compared to men with no obstructive sleep apnea (OSA) (referent group), men with severe OSA (but not milder forms) had a higher odds of having some depressive symptoms (OR = 1.43, 95%CI = 1.03-1.99), but not of being depressed (OR = 1.11, 95%CI = 0.65-1.89) in age/ site adjusted models. However, the association between severe OSA and some depressive symptoms was in part due to greater BMI among men with severe SA (OR adjusted for age, site and BMI = 1.33, 95%CI = 0.95-1.87).

Conclusion: Elderly community-dwelling men with severe SDB are at a higher odds of reporting depressive symptoms (but not of being depressed) in part explained by a higher BMI among those with SDB. Prospective studies are needed to evaluate the temporality of the association between SDB and depression.

Support (If Any): National Institutes of Health funding.

0800

THE ASSOCIATION OF DEPRESSIVE SYMPTOMS WITH POLYSOMNOGRAPHIC ASSESSED SLEEP AND SELF-RATED SLEEP: A POPULATION-BASED STUDY

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Introduction: Depression and sleep are intrinsically related. Research in population-based studies of depressive symptoms has mainly assessed sleep by self-rating, which might bias results. We compared the associations of depressive symptoms with self-rated sleep and sleep assessed with polysomnography (PSG).

Methods: The Pittsburgh Sleep Quality Index (PSQI) and a 1-night ambulant PSG were collected in 444 participants of the Rotterdam Study (age 62 ± 5.2 years, mean ± standard deviation). In the PSQI participants rated their total sleep time (TST), sleep onset latency (SOL) and sleep efficiency (SE). PSG recordings were scored according to the AASM criteria by a licensed sleep technician to assess TST, SOL and SE. SOL and SE were transformed to normalize the distribution, all sleep variables were standardized to facilitate interpretation. Depressive symptoms were assessed with the Center for Epidemiologic Studies Depression scale. We used linear regression analyses adjusted for sex, age, education, employment, cognitive functioning, body mass index, smoking, alcohol use, coffee use and use of sleep medication.

Results: More depressive symptoms were associated with self-rated TST (B = -0.02 per point change in depressive symptoms, p = 0.004), self-rated SOL (B = 0.02 per point change, p = 0.002) and self-rated SE (B = -0.04 per point change, p < 0.001) when fully adjusted. However, more depressive symptoms were only related to a longer SOL (B = 0.02 per point change, p = 0.033) when sleep was assessed with PSG. Exclusion of participants with a clinical diagnosis of depression did not attenuate the results.

Conclusion: Depressive symptoms were related to sleep characteristics if assessed by self-rating. In contrast, when we assessed sleep with PSG, depressive symptoms were only related to a longer SOL. These preliminary results suggest that the self-rating of sleep may bias the association between depressive symptoms and sleep. Data collection and analyses of microstructure are ongoing and results will be presented.

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0801

ASSOCIATIONS BETWEEN THE LIFETIME MOOD SPECTRUM AND THE DEPRESSIVE SLEEP PROFILE

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Introduction: Sleep indices are involved in the diagnosis, treatment, and understanding of the clinical course of affective disorders. Depression has generally been associated with REM disinhibition, dysregulated slow wave sleep (SWS), sleep fragmentation, and poor sleep quality, although results have been inconsistent. The current conceptualization of mood disorders suggests that a dimensional approach spanning depressive and hypomanic features may better explain the variability of sleep profiles observed in depression. This study investigates whether hypomanic nuances of affective presentation are associated with these dimensions of sleep in individuals with and without a history of depression.

Methods: Overnight polysomnography (PSG) was recorded in 155 participants (age = 60.15 ± 9.04 years, 69% female, 63.1% lifetime depression diagnosis). Composite variables were created for REM disinhibition (REM latency, number of REM periods) and dysregulated SWS (delta sleep ratio, delta spectral power). PSG-assessed sleep efficiency was used to measure sleep fragmentation and the Pittsburgh Sleep Quality Index (PSQI) quantified subjective sleep quality. Mental health was assessed using the Structured Clinical Interview for DSM-IV, the Hamilton Rating Scale for Depression (HRSD), and the lifetime self-report Mood Spectrum (MOODS-SR). MOODS-SR subscales assess temperamental affective dysregulation in depressive and manic-hypomanic domains across an individual's lifetime. Linear regression examined whether scores on the MOODS-SR Hypomanic Cognitions, Hypomanic Energy/Behaviors, and Hypomanic Moods subscales were significant correlates of sleep outcomes. Analyses adjusted for age, sex, antidepressants/benzodiazepines, medications that affect sleep, napping, depression diagnosis, and HRSD score.

Results: Higher Hypomanic Energy/Behaviors scores were associated with greater SWS dysregulation (p = 0.016). Scores on all three hypomanic subscales were associated with greater sleep fragmentation (p's < 0.03) and poorer sleep quality (p's < .005).

Conclusion: Across individuals with and without a history of clinical depression, hypomanic symptoms are associated with impairments in sleep continuity, quality, and depth. This spectrum approach to affective disorders helps broaden our understanding of differential sleep presentation, and suggests that some individuals scoring higher on hypomanic scales may benefit from multi-dimensional interventions to improve their sleep and functioning.

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0802

EXCESSIVE DAYTIME SLEEPINESS AND DEPRESSION IN HISPANIC AMERICANS

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Introduction: Excessive daytime sleepiness (EDS) has been shown to be associated with depression; however, this relationship has not been confirmed among the Hispanic American (HA) community. This investigation evaluated the relationship between EDS and depression in HAs, and examined the moderational roles of age, gender, income, education, health status, and acculturation on this relationship.

Methods: HA community-dwelling adults (N = 436) completed questionnaires in English or Spanish. The Epworth Sleepiness Scale (Epworth) measured EDS and the PHQ-9 assessed depression. ROC curve analysis examined the Epworth's ability to indicate depression. Hierarchical linear regression (HLR) evaluated moderators through six models, each including EDS, one sociodemographic variable, and the interaction between EDS and that variable as predictors, and depression as the outcome. A final regression model examined the relationship between EDS and depression after controlling for the six sociodemographic variables.

Results: ROC curve analysis suggested that, at an optimal cutoff value of seven, the Epworth discriminated with adequate sensitivity (.77) and specificity (.62) between participants with moderately severe depression and those with less severe symptoms. This cutoff resulted in a better balance of sensitivity (.50) and specificity (.81) than a cutoff of 10. In the HLR analyses, EDS was consistently a significant ($p < .01$) predictor of depression; no sociodemographic variables moderated the EDS-depression relationship. EDS remained significantly related to depression after controlling for sociodemographics. This final model accounted for 25% of the variance in depression.

Conclusion: EDS can be considered an indicator for depression in HAs. Additionally, EDS as measured by the Epworth is a suitable indicator of whether a person is likely to have moderately severe depression versus less severe levels. This is based on an Epworth cutoff of seven, which falls in the normal range. Thus, healthcare professionals encountering HA patients presenting with complaints of even mild EDS should consider depression as a potential cause.

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0803

CORRELATES OF SLEEP COMPLAINTS AMONG DEPRESSED ELDERLY INDIVIDUALS

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Introduction: It has been reported that sleep complaints among patients with major depression increase the severity and treatment resistance of depression. As some depressed patients do not complain of sleep problems, we sought to determine characteristics associated with sleep complaints among depressed, elderly individuals. We also sought to determine whether these characteristics differ from correlates of sleep complaints in the general elderly population.

Methods: Data on 22,000 elderly individuals were extracted from the 2008 and 2010 waves of the Health and Retirement Study (HRS), which enrolled about 22,000 elderly individuals. Individuals were identified as depressed if they self-reported depression on both the 2008 and 2010 waves of the HRS study and were currently receiving treatment (N = 1,292). Sleep complaints included trouble falling asleep, waking during the night, waking too early, or non-refreshing sleep. Polyordinal logistic regression identified characteristics associated with an increasing number of sleep complaints. Odds ratios (ORs) for depressed individuals were compared with corresponding ORs for the entire HRS cohort.

Results: In depressed individuals, sleep complaints were strongly associated with worsening depression, lower self-rated health, and lower life satisfaction ($p < 0.001$, for all). While age less than 60, Black race, Hispanic ethnicity, or being foreign-born were not correlates of sleep complaints among the entire HRS cohort, they were all significant correlates among depressed elderly (OR = 1.50, OR = 1.74, OR = 2.04, OR = 2.33, respectively; $p < 0.01$ for all). Other correlates for elderly depressed individuals with increasing sleep complaints included female gender, high school graduate or less, and current smoking. Odds ratios for these factors were similar for depressed individuals and the entire cohort.

Conclusion: We confirmed that among elderly depressed individuals, sleep complaints are associated with worse outcomes. Sleep complaints among depressed elderly may have different demographic correlates from sleep complaints in the general population; reasons for this discrepancy, such as differential care or treatment compliance, should be explored.

0804

INSOMNIA, HYPERSOMNIA AND FATIGUE ARE INDEPENDENTLY ASSOCIATED WITH DEPRESSIVE DISORDERS (ICD9-CM CODES 296.311): RESULTS FROM A NATIONALLY REPRESENTATIVE US SAMPLE OF 37,171 PATIENT VISITS FOR DEPRESSION

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Introduction: Insomnia or hypersomnia nearly every day (Criterion A.4, Diagnostic and Statistical Manual of Mental Disorders, 5th edition, 2013, DSM-5) and fatigue or loss of energy nearly every day (Criterion A.6, DSM-5) are primary clinical features of Major Depressive Disorder (DSM-5). Clinically, insomnia, hypersomnia and fatigue may be interrelated and can pre-date the onset of depression. We examined the association of insomnia, hypersomnia and fatigue and depressive disorders (DD) in a nationally representative sample of patient visits from 1995-2010.

Methods: An estimated 399,309,578 \pm 17,454,766 patient visits (unweighted count 37,171) with physician diagnosed DD (ICD9-CM codes 296.2, 296.3, 296.82, 296.20 to 296.36 for major depressive disorder, ICD9-CM code 311 for Depression Not Elsewhere Classified) (mean \pm SE age: 46.66 \pm 0.25; 67.7 \pm 0.5%female; 89.0 \pm 0.6% 'white', 8.3 \pm 0.5% 'black') were studied from the National Ambulatory Medical Care Survey and National Hospital Ambulatory Care Survey. The DD variable was compared to all other visits. Variables for 'Insomnia' (ICD9-CM codes 780.52, 307.41, 307.42, 327.00, 327.01, 327.02, 327.09 and 'Reason for Visit' insomnia), 'Hypersomnia' (ICD9-CM codes 780.54, 327.10, 327.11, 327.12, 327.14, 327.15, 327.19, 307.43, 307.44 and 'Reason for Visit' hypersomnia) and 'Fatigue' ('Reason for Visit' tiredness, fatigue, exhaustion), and major groups of psychotropic drugs used in the treatment of DD that can have insomnia, hypersomnia or fatigue as side effects and thereby confound sleep-related symptoms, were created.

Results: Logistic regression analysis using DD as the dependent variable, and 'Insomnia', 'Hypersomnia', 'Fatigue', sex, age, and several psychotropic agents (antipsychotics, antidepressants, 'Z' drugs, benzodiazepines and stimulants) as independent variables revealed that 'Insomnia' (odds ratio or OR = 2.12, 95% CI 1.83-2.45), 'Hypersomnia' (OR = 1.70, 95% CI 1.11-2.62) and 'Fatigue' (OR = 2.03, 95% CI 1.74-2.38), sex (female vs. male) (OR = 1.12, 95% CI 1.13-1.25) and all psychotropics, excluding 'Z' drugs, were all significantly associated with DD. Logistic regression analysis excluding all psychotropics as independent variables revealed the following odds ratios: 'Insomnia': OR = 6.95, 95%CI 6.19-7.79; 'Hypersomnia': OR = 3.18, 95% CI 2.12-4.79; 'Fatigue': OR = 3.17, 95% CI 2.79-3.62; and sex (female vs. male) (OR = 1.47, 95%CI 1.40-1.54).

Conclusion: In a nationally representative sample, insomnia, hypersomnia and fatigue were independently associated with physician-diagnosed depressive disorders, diagnosed using ICD9-CM criteria, even after controlling for demographic factors and psychotropic medications used in the treatment of depression that can theoretically confound the presentation of sleep-related complaints. To our knowledge this is the first reported study that has examined insomnia, hypersomnia and fatigue, all primary sleep-related diagnostic criteria (as per DSM-5) of major depressive disorder, in an epidemiologically representative sample.

0805

PSYCHOMOTOR VIGILANCE PREDICTS INSOMNIA SEVERITY BUT NOT DEPRESSION SEVERITY IN PATIENTS WITH MAJOR DEPRESSION

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Introduction: Major depression and insomnia are highly comorbid and clinical trials have shown that treating insomnia improves core depression symptoms. It is not clear however, if patients with major depression who report insomnia suffer from a true sleep. The analyses reported here were completed to test the hypothesis that in patients with major depression, greater insomnia severity would predict impaired vigilance, a hallmark feature of insufficient sleep.

Methods: Participants (N = 40) were recruited; 22 met criteria for major depression based on a structured clinical interview (SCID-I) and 18 were healthy controls. Subjective measures included the Karolinska Sleepiness Scale (KSS) Insomnia Severity Index (ISI) and Beck Depression Inventory (BDI-II). The 3-minute PVT-B was used to assess psychomotor vigilance. These measures were not normally distributed in our sample ($p < 0.005$), therefore nonparametric statistics were used for all analyses.

Results: Participants were 40 adults, 22 with major depression. Patients with major depression reported greater insomnia severity ($p = 0.21$). For patients with major depression insomnia severity was significantly related to PVT-B lapses ($r = 0.49$, $p = 0.04$). Subjective sleepiness was also strongly related insomnia severity, but failed to meet criteria for statistical significance ($r = 0.41$, $p = 0.09$). Depression severity was not significantly associated with subjective sleepiness, nor to either of the primary PVT metrics (all $ps > 0.29$).

Conclusion: These analyses suggest that self-reported insomnia in people with major depression is associated with objective impairments in psychomotor vigilance that are similar to those observed in sleep deprivation experiments. In addition, the PVT-B may be useful in clinical research as well as experimental sleep deprivation studies.

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0806

RAILWAY SUICIDE ATTEMPTS ARE ASSOCIATED WITH AMOUNT OF SUNLIGHT IN RECENT DAYS

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Introduction: In the Tokyo Metropolitan Area in Japan, almost half of all train delays were caused by suicides. Bright lights have been shown to be effective for both seasonal and non-seasonal depression within a week. When blight light therapy stops, depressive symptoms typically relapse within about a week. Thus, we hypothesized that the hours of sunlight in the days preceding the suicidal attempt may affect suicidal behavior. In order to test this hypothesis, we analyzed the association between railway suicide attempts and duration of sunlight in the past few days.

Methods: Data were obtained from the Railway delay incident database of Japanese Railway Technical Research Institute and the public weather database of the Japan Meteorological Agency. We used "suicide" as the key word to search for incidents between 1 January 2002 and 12 December 2006. "Hours of sunlight" were defined as the duration of hours when direct sunlight of 0.12 kw/m² or more reached the ground. Tokyo, Kanagawa, and Osaka prefectures were chosen as the target areas, because the numbers of railway delays caused by suicide were highest in these three prefectures across Japan. Linear probability model was used to assess a relationship between railway suicidal attempts and sunlight. Statistical analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC). This study protocol was approved by the Kyoto University Graduate School and Faculty of Medicine Ethics Committee (#823).

Results: 971 railway suicides were attempted during 2002 to 2006 in Tokyo, Kanagawa and Osaka. Less sunlight during the seven days before the railway suicidal attempts were associated with increased proportion of the attempts ($p = 0.0243$). Sunlight of the three days before had similar trend ($p = 0.0888$). No difference was found in sunlight hours between days with (median: 5.6 [IQR: 1.1-8.8]) and without (median: 5.7 [IQR: 1.0-8.9]) railway suicidal attempts in the evening. No apparent correlation was found between the railway suicidal attempts and monthly average sunlight hours.

Conclusion: Increased railway suicidal attempts were found after several days without sunlight. Light exposure (blue light or bright white light) in trains may be useful to reduce railway suicides, especially when consecutive days without sunshine are forecasted.

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0807

EFFECTS OF A HOMEOSTATIC SLEEP CHALLENGE ON MOOD IN HEALTHY AND DEPRESSED ADOLESCENTS AND ADULTS

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Introduction: Sleep deprivation has been shown to alleviate depressive symptoms in depressed patients in the short-term (Gillin, Buschbaum, Wu, Clark, & Bunney, 2001). Recently, a study by Landsness and colleagues (2011) demonstrated that decreases in SWA result in decreases

in depressive symptoms. The aim of the present study was to determine if a mild homeostatic sleep challenge altered mood in a sample of depressed and healthy adolescents and adults.

Methods: Four groups of participants were used: (a) non-depressed adults, (b) adults with MDD, (c) non-depressed adolescents and (d) adolescents with MDD. Participants spent three consecutive nights in the sleep laboratory (Adaptation, Baseline, Delay). On the third night in the lab, bedtime was delayed by three hours, as this procedure has been shown to increase slow-wave EEG activity in the first part of the night. The Profile of Mood Scores questionnaire (POMS) was recorded on the morning following the baseline and sleep delay nights.

Results: Repeated measures ANOVA analyses of each of the six subscales of the POMS for adults revealed significant main effects for the sleep manipulation for Anger, Depression, and Vigor. Results for adolescents revealed significant main effects for the sleep manipulation for Anger, Vigor, and Fatigue. Means indicated that all subscale scores decreased following sleep delay. Additionally, post-hoc t-tests also revealed that the MDD groups showed no significant differences in mood before and after the SWA delay.

Conclusion: These analyses showed that the SWA delay paradigm did impact mood in healthy adults and adolescents, resulting in improved mood on several of the POMS subscales. The sleep manipulation, however, did not seem to alter the mood of depressed adults or adolescents. This may indicate that those with MDD require a more significant sleep manipulation, including sleep deprivation, to impact mood.

0808

COMBINED TOTAL SLEEP DEPRIVATION, SLEEP PHASE ADVANCE, AND BRIGHT LIGHT THERAPY IN SUICIDAL DEPRESSED INPATIENTS: AN OPEN LABEL PILOT STUDY

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Introduction: Previous studies have demonstrated that combined total sleep deprivation, sleep phase advance, and bright light therapy (Triple Chronotherapy) produce a rapid and sustained antidepressant effect in acutely depressed individuals. To date no studies have explored the impact of the intervention on depressed individuals with acute concurrent suicidality.

Methods: Participants were suicidal inpatients (N = 4, Mean age = 36, 2F) with unipolar depression. In addition to standard of care, they received open label Triple Chronotherapy. Participants underwent one night of total sleep deprivation (33-36 hours), followed by a three-night sleep phase advance along with four 30-minute sessions of bright light therapy (10,000 lux) each morning. Primary outcome measures included the 17 item Hamilton depression scale (HAM17), and the Columbia Suicide Severity Rating Scale (CSSRS), which were recorded at baseline prior to total sleep deprivation, and at the protocols completion on day five.

Results: Both HAM17, and CSSRS scores were greatly reduced at the conclusion of the protocol. Ham17 scores dropped from a mean of 26.8 at baseline to a mean of 7.5 on day five ($p < .01$) with three of the four individuals meeting criteria for remission. CSSRS scores dropped from a mean of 25.3 at baseline to a mean of 6 on day five ($p = .02$).

Conclusion: The interim results of this small pilot trial demonstrate that adjunct Triple Chronotherapy is feasible and tolerable in acutely suicidal and depressed inpatients. Limitations include a small number of participants, an open label design, and the lack of a comparison group.

Support (If Any): NIDA R25 DA020537-06 (PI's Back and Brady).

0809

BEHAVIORAL ACTIVATION (BA) TREATMENT FOR DEPRESSION COMORBID WITH INSOMNIA IMPROVES SLEEP QUALITY AND SLEEP-DEPENDENT MEMORY CONSOLIDATION

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Introduction: Patients with major depressive disorder (MDD) often complain of insomnia and memory problems. Behavioral activation (BA) interventions have been shown to be an effective treatment for depression; however, its effect for comorbid insomnia in depression has not been established. The aim of present study was to examine the treatment effects of adding BA treatment to antidepressant medication on sleep quality and memory consolidation in depression patients.

Methods: Eleven inpatients (42.6 ± 7.5 years, 7 female) with MDD and insomnia were included. At the end of their first week of hospitalization, they underwent an 8-session BA treatment that was conducted over the course of 4 weeks. A task for sleep-dependent memory consolidation was also given twice, once before and once after the treatment. They were asked to memorize 20 semantically related word pairs, and followed by cued-recall task prior to and after a night of sleep. All participants completed the Beck Depression Inventory (BDI) and Insomnia Severity Index (ISI) to assess the treatment effects on depression and insomnia symptoms.

Results: Significant reductions after BA treatment on BDI as well as ISI scores were observed ($t = 9.03$ and 8.06 , respectively, $ps < .01$). The percentage of over-night memory improvement after BA intervention was significantly larger than that prior to treatment ($t = -2.70$, $p < .05$). Moreover, the over-night changes of memory in post-treatment session were negatively correlated to BDI scores ($r = -0.70$, $p < .05$).

Conclusion: This pilot study showed that BA treatment can improve sleep quality and sleep-dependent memory consolidation in depression patients comorbid with insomnia.

0810

PROLONGED USE OF HYPNOTICS IN PATIENTS WITH FIRST-EPISODE MAJOR DEPRESSION AFTER DISCONTINUATION OF ANTIDEPRESSANTS

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Introduction: Previous studies suggested that many residual psychiatric symptoms, especially insomnia, were still persisted after remission of major depressive episode. The temporal association among the use of antidepressant, the use of hypnotics, and the relapse of major depressive episode was less investigated.

Methods: By using Taiwan National Health Insurance Research Database (NHIRD), 944 patients with first-episode major depression and having ≥ 2 -month treatment of antidepressant in 2003 were enrolled and stratified into four groups (A: longer use of hypnotics than antidepressant [$n = 195$]; B: longer use of antidepressant than hypnotics [$n = 203$]; C: simultaneous discontinuation of antidepressant and hypnotics [$n = 317$]; D: without combined use of hypnotics [$n = 145$]) for investigation of the association between the relapse of another major depressive episode and the use pattern of antidepressant and hypnotics. The six-month antidepressant or hypnotics-free was defined as the discontinuation of medication and set as a proxy of symptom-free condition. The next ≥ 2 -month treatment of antidepressant was set as a proxy of relapse of

another major depressive episode. Those with the persistent use of antidepressant and hypnotics ($n = 84$) were excluded in our study.

Results: The median interval between the discontinuation of antidepressant and hypnotics differed significantly in those with longer use of hypnotics than antidepressant and those with longer use of antidepressant than hypnotics (2.97 ± 0.58 vs. 0.95 ± 0.15 years, $p < 0.001$). Depressive patients who had longer use of hypnotics than antidepressant exhibited a higher prevalence (47.6% vs. 33.0% vs. 35.0% vs. 36.6% , $p < 0.001$) with a shorter interval (1.13 ± 0.10 vs. 1.89 ± 0.31 vs. 2.87 ± 0.43 vs. 2.37 ± 0.47 , $p < 0.001$) of the relapse of another major depressive episode compared to those who had longer use of antidepressant than hypnotics, those who discontinued antidepressant and hypnotics simultaneously, and those who never used hypnotics.

Conclusion: The longer use of hypnotics after the discontinuation of antidepressant implicated the persistent insomnia symptoms in remitted major depression patients. Residual symptoms should be carefully treated and followed because persistent insomnia can increase the risk of relapse into another major depressive episode.

0811 NEUROPSYCHOLOGICAL FUNCTIONING FOLLOWING FLUOXETINE AND REPEATED PARTIAL SLEEP DEPRIVATION IN ADULTS WITH MAJOR DEPRESSIVE DISORDER

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Introduction: Depressed adults experience difficulties with attention, executive functioning and emotional perception of facial expressions, yet little is known about neuropsychological functioning relative to sleep during antidepressant therapy initiation. In a randomized controlled trial evaluating the effects of repeated partial sleep deprivation (PSD) on antidepressant response, we evaluated neuropsychological functioning in young adults with MDD during the first two weeks of fluoxetine therapy.

Methods: Sixty-eight adults meeting DSM-IV criteria for MDD (25 ± 6 years old, 50% women, 77% Caucasian) received 8 weeks of fluoxetine 20-40 mg and were randomized to 8 hours time in bed (No PSD) or 6 hours time in bed (PSD) during the first two weeks. At baseline and at the end of week two, participants completed a neuropsychological battery with measures sensitive to sleepiness and depressive symptoms.

Results: Fifty-three participants (78%) completed the neuropsychological battery at both time points. Repeated measures ANCOVAs with education, sex and adherence as covariates indicated significant time by group interactions for measures of verbal learning and facial emotion perception. On the Facial Emotion Perception Test, the PSD group had greater accuracy for faces with negative affect ($p < .05$) and were slower to respond to stimuli with negative affect relative to happy faces ($p = .01$) at two weeks compared to the No PSD group. More specifically, the PSD group more accurately identified angry faces ($p < .05$) and more slowly processed sad faces than the No PSD group ($p < .05$). The PSD group recalled more words presented at the end of the Buschke Selective Reminding Test of auditory verbal memory (i.e. recency items) at two weeks than the No PSD group ($p < .01$). No effects were observed for measures of attention, inhibitory control, visual-spatial or motor performance.

Conclusion: Insufficient sleep during the early stages of antidepressant therapy may adversely impact emotional perception. We are exploring how these changes relate to disease characteristics and treatment response.

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0812

DO EARLY TRADITIONAL VERSUS PROGRESSIVE PARENTING BELIEFS PREDICT SLEEP PROBLEMS LATER IN CHILDHOOD?

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Introduction: Parenting laxness and difficulty with limit-setting are associated with greater sleep problems in children, yet few studies have explored the predictive value of these parenting beliefs in forecasting sleep problems during early development. An authoritative parenting style is characterized by appropriate limit-setting and may promote self-regulation and independent sleep. The current study examined the impact of traditional (authoritarian) versus progressive (egalitarian) parenting beliefs during infancy on child sleep problems around the time of school entry.

Methods: Participants were healthy newborns ($N = 1,364$) enrolled in the NICHD SECCYD study. Caregivers completed the Parental Modernity Scale at one month of age, which included two subscales measuring authoritarian beliefs (traditional subscale) and egalitarian beliefs (progressive subscale). Caregivers also completed the Child Behavior Checklist (CBCL) at 54 months, kindergarten, and 1st grade. Multivariate regression analyses were conducted to examine relationships between parenting beliefs during infancy and child sleep problems at 54 months, kindergarten, and 1st grade (controlling for infant sleep problems).

Results: The overall multivariate effect of all variables in the model was significant, Wilks' $\Lambda = 0.00$, $F(3642, 2013) = 1.14$, $p = 0.001$, although multivariate effects for traditional beliefs, Wilks' $\Lambda = 0.99$, $F(6, 941) = 1.18$, $p = 0.32$, or progressive beliefs, Wilks' $\Lambda = 0.99$, $F(6, 941) = 0.81$, $p = 0.57$, specifically were not significant. Univariate ANOVA's revealed that traditional parenting significantly predicted total sleep problems at 54 months, $F(1, 946) = 4.94$, $p < 0.05$.

Conclusion: Sleep problems during the transition to school are common and are associated with poorer academic performance and socioemotional outcomes, thus representing a critical period for intervention. Early beliefs about child-rearing practices may have an impact on children's sleep during this period and may be viable targets for early prevention and treatment.

0813

EXAMINING THE ROLE OF EMOTION REGULATION DIFFICULTIES IN THE RELATIONSHIP BETWEEN PSYCHOLOGICAL SYMPTOMS AND INSOMNIA SEVERITY

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Introduction: Previous research has demonstrated a relationship between emotion regulation (ER) difficulties and psychological symptoms such as depression, anxiety, and stress. Further, there is evidence to suggest that insomnia is associated with similar symptoms; however, the role of emotion regulation in the relationship between insomnia and psychological symptoms is unknown. The current study investigated the relationship between insomnia severity, ER difficulties, and psychological symptoms.

Methods: Data were collected from 468 undergraduate students using in-person survey methodology. Constructs of interests were assessed using the Depression Anxiety Stress Scale, the Insomnia Severity Index, and Difficulties in Emotion Regulation Scale.

Results: A series of hierarchical regression analyses were conducted to examine the relationship between insomnia severity, ER difficulties, and psychological symptoms while controlling for global sleep qual-

ity and daytime sleepiness. Although inconsistent across psychological symptom subtypes, results indicated a significant interaction between insomnia severity and ER difficulties in the prediction of depression symptoms ($R^2 = .46$, $\beta = .086$, $p < .05$). Simple slope analyses revealed a significant difference in depression symptoms across insomnia severity levels at high ($\beta = .13$, $p < .05$), but not low ($\beta = -.21$, $p = .84$) levels of ER difficulties. Only main effects were observed for anxiety and stress symptoms.

Conclusion: The results suggest that ER difficulties may play an important role in the relationship between insomnia severity and depression symptoms. Specifically, when ER difficulties are highest, depression symptoms increase with an increase in insomnia. Further, when ER difficulties are lowest, there is no difference in depression symptoms across insomnia severity. The findings highlight the clinical importance of considering the role of emotion regulation in the development of depression symptoms within the context of insomnia.

0814

RELATIONSHIPS BETWEEN EMOTIONAL DISTRESS AND INADEQUATE SLEEP DURATION: ANALYSIS OF THE 2009 NATIONAL HEALTH INTERVIEW SURVEY

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Introduction: Inadequate sleep duration is an important public health burden in the United States. However, there is a paucity of information on the relationships between psychological health and inadequate sleep. Our study examined the relationships between emotional distress and inadequate sleep.

Methods: Data from the 2009 National Health Interview Survey (NHIS), N = 27,731 participants 18 years and older, were analyzed to investigate the associations of emotional distress with inadequate sleep duration, adjusting for socio-demographic factors, health risks, and chronic diseases. We define inadequate sleep as less than 7 or greater than 8 hours sleep durations; compared to healthy sleep (7-8 hours). We measured emotional distress, based on Kessler's 6 scale, which assesses the frequency of feeling sad, nervous, restless, hopeless, worthless, and burdened over a 30-day period. Responses were used to generate a score ranging from 0 to 24. Scores of ≥ 13 are considered likely to indicate serious mental illness.

Results: Of the sample, 52% were female, 80% were white, 12% black, and 8% other; 30% hold a HS diploma and 31% reported a family income below 31K. Analysis also showed that 10.9% reported emotional distress and 37.2% reported inadequate sleep. Results of our logistic regression analysis revealed that individuals with emotional distress had 57% greater odd of reporting inadequate sleep (OR = 1.5795% C.I. 1.54, 1.61, $p < 0.001$); the model adjusted for age, sex, race/ethnicity, marital status, education, combined family income, body mass index, history of alcohol consumption, smoking status, and chronic diseases including, arthritis, hypertension, diabetes, cancer, coronary heart disease and heart conditions.

Conclusion: Our findings showed that emotional distress, an important proxy for psychological health, was the strongest predictor of inadequate sleep. Other factors associated with inadequate sleep include demographic (age, education, sex, race/ethnicity, combined family income), health risks (alcohol consumption, smoking status), and chronic

disease/conditions (diabetes, obesity, hypertension, heart disease, cancer and arthritis).

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0815

DIFFERENT AFFECT STATES TARGET DISTINCT ACTIGRAPHY-BASED SLEEP PARAMETERS

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Introduction: Despite sharing a common factor of negative valence, affect states such as sadness, anxiety, and hostility vary in terms of the content of associated cognitions as well as the nature of motivational/appetitive behaviors they elicit. As such, these affect states are associated with distinct clinical outcomes. Though prior research has established an association between negative affect and overall sleep disturbance, there is presently no evidence that specific affect states target different sleep parameters.

Methods: Our data derive from the control week of a clinical trial of mindfulness-based meditation in a sample of university students ($n = 42$; 19.6 ± 3.2 yo; 73.8% female). Prior to bed each night, participants reported daily levels of sadness and anxiety on the Positive and Negative Affect Schedule (PANAS). Sleep was monitored throughout this seven day period via wrist actigraphy. Lagged-effect, hierarchical-linear-models were used to assess the impact of daily levels of affect on three sleep indices: sleep-onset latency (SOL), total sleep time (TST), and sleep efficiency (SE), while covarying for baseline sleep disturbance and demographic characteristics.

Results: Daily sadness was significantly predictive SOL, such that a 1 SD increase on the sadness subscale was associated with a 9 minute increase in SOL ($z = 3.73$, $p < .01$). Though daily anxiety was unrelated to SOL, a 1 SD increase in the daily anxiety subscale was predictive of a 25 minute decrease in TST ($z = -2.37$, $p < .05$) and a 1.6% decrease in SE ($z = -2.13$, $p < .05$).

Conclusion: These data suggest that while sadness is primarily associated with sleep onset difficulties, anxiety predicts poor sleep maintenance. These findings parallel recent research on the differential effects of rumination and worry on sleep disturbance, lending further credence to the parity between sadness and rumination on one hand and worry and anxiety on the other.

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0816

MARIJUANA USE PATTERNS AND SLEEP AMONG COMMUNITY-BASED YOUNG ADULTS

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Introduction: Marijuana (MJ) is one of the most commonly used illicit drugs in the United States. The availability of MJ for medicinal purposes in many states is increasing. Few naturalistic studies have examined the relationship between specific patterns of MJ use and sleep. This study examined the association between patterns of marijuana use and sleep quality in non-treatment seeking community members.

Methods: A total of 78 subjects (36 M; 42 F) ages 18-30 (median = 22), who were recruited online or through university advertising and reported no binge alcohol or other drug use, were administered the Time

Line Follow Back (TLFB) interview, documenting MJ use across the past 30 days. MJ use patterns are defined by minutes of MJ use per day. Groups were categorized as non-daily users ($n = 26$), daily users ($n = 38$), and non-user controls ($n = 14$). All subjects completed an Insomnia Severity Index (ISI), a Pittsburgh Sleep Quality Index (PSQI), an Epworth sleepiness scale (ESS), and a Morningness Eveningness Questionnaire (MEQ).

Results: Group comparisons, adjusting for employment, gender, anxiety, and depression revealed statistical differences ($p < .05$) between non-daily and daily use on the PSQI (4.8 ± 3.3 vs. 7.4 ± 4.2), ISI (4.9 ± 4.5 vs. 8.2 ± 6.3) but not in the ESS (6.1 ± 3.7 vs. 5.8 ± 3.8) or MEQ (32.1 ± 8.0 vs. 30.7 ± 6.6). A criterion for clinical insomnia ($ISI \geq 10$) was met in 36.8% of daily users, 7.7% of non-daily users, and 21.4% of non-users. No differences were found between non-daily users and non-users on the PSQI, ISI, ESS, or MEQ.

Conclusion: Daily MJ users endorsed more sleep disturbance than non-daily users. Non-daily users and non-users had similar sleep indices. Further research exploring the relationship between frequency of MJ use and sleep is warranted.

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0817

PATTERNS OF MARIJUANA (CANNABIS) USE AND SLEEP SYMPTOMS IN AMERICAN ADULTS

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Introduction: Cannabis is commonly used in the population, with a higher prevalence of use in adolescents. Prior studies have associated cannabis use and insomnia, mainly in adolescents. It is possible that this relationship differs in adults, depends on age at first use, and differentially affects insomnia symptoms.

Methods: Data from the 2007-2008 NHANES were used ($N = 3255$ adults age 20-59 asked about drug use history). Cannabis use was assessed as (1) any history of use, (2) age at first use (15 yrs or earlier, 16-18 yrs, > 18 yrs), and (3) number of times used in the past month (among $N = 1811$ with history of use). Sleep symptoms included difficulty falling asleep, difficulty maintaining sleep, non-restorative sleep, and daytime sleepiness, coded as minimal (< 5 days/month), mild (5-15 days/month) and severe (≥ 15 days/month). Population-weighted, multinomial logistic regression analyses examined whether marijuana use was associated with likelihood of sleep symptoms, after adjustment for age, sex, race/ethnicity, education, income, body mass index, and smoking.

Results: Any history of cannabis use was associated with increased likelihood of mild ($OR = 1.39$, $p = 0.045$) and severe ($OR = 1.60$, $p = 0.018$) difficulty falling asleep, mild ($OR = 1.43$, $p = 0.031$) difficulty maintaining sleep, mild ($OR = 1.34$, $p = 0.005$) and severe ($OR = 1.74$, $p = 0.001$) non-restorative sleep, and mild ($OR = 1.53$, $p = 0.006$) daytime sleepiness. Regarding age at first use, relative to non-users, those who started at < 15 yrs were more likely to experience severe difficulty falling asleep ($OR = 2.28$, $p = 0.001$), mild ($OR = 1.60$, $p = 0.026$) and severe ($OR = 1.78$, $p = 0.049$) difficulty maintaining sleep, mild ($OR = 1.86$, $p < 0.0001$) and severe ($OR = 2.25$, $p < 0.0001$) non-restorative sleep, and mild ($OR = 1.60$, $p = 0.016$) and severe ($OR = 1.99$, $p = 0.013$) daytime sleepiness. For those who began at 16-18, effects were seen for mild difficulty falling asleep ($OR = 1.47$, $p = 0.048$), mild difficulty maintaining sleep ($OR = 1.50$, $p = 0.043$), mild non-restorative sleep ($OR = 1.39$, $p = 0.047$), and mild daytime sleepiness ($OR = 1.53$, $p = 0.021$). Those who began after 18 yrs demonstrated no relationships except with severe nonrestorative sleep ($OR = 1.67$, $p = 0.019$). Among users, frequency of

use was associated with severe difficulty falling asleep ($OR = 1.03$, $p = 0.027$).

Conclusion: Frequent cannabis use is associated with impaired sleep quality. Initiation of cannabis use in adolescence may impart a higher risk for subsequent insomnia symptoms.

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0818

THE IMPACT OF ALCOHOL HANGOVER AND TOTAL SLEEP TIME ON SIMULATED HIGHWAY DRIVING

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Introduction: An evening out consuming alcohol often occurs at the expense of sleep time. The purpose of this study was to investigate the effects of alcohol hangover on driving performance, and to examine the mediating properties of sleep time on hangover related performance impairment.

Methods: $N = 42$ healthy volunteers conducted a 100-km simulated highway driving test the morning following an evening of consuming on average 10.2 (4.2) alcoholic drinks (alcohol hangover) and on a control day (no alcohol consumed). Subjects performed the simulated highway driving test when blood alcohol concentration (BAC) was zero. Standard Deviation of Lateral Position (SDLP, i.e. the weaving of the car) and lapses in driving were measured. A lapse was defined as a change of lateral position of > 100 cm for at least 8 seconds. Δ SDLP (hangover – control) and Δ lapses were related to total sleep time. Performance as compared between subjects who slept less than 5 hours, 5 to 7 hours, and more than 7 hours.

Results: A significant increase in both SDLP (+1.9 cm, $p = 0.007$) and the number of lapses (+2.4, $p = 0.019$) was observed during alcohol hangover. Relative to the control day, total sleep time was significantly reduced by on average 120 minutes in the alcohol hangover condition. Total sleep time had a moderating effect on Δ SDLP (hangover – control), in that subjects who slept less than 5 hours showed a larger Δ SDLP than those who slept 5 to 7 hours or more than 7 hours (+3.3 cm, +1.0 cm, and -0.1 cm, respectively). A reduced impact on driving performance was not seen when looking at Δ lapses of the different sleep duration groups (+2.3, +2.8, and +1.8, respectively).

Conclusion: Driving is significantly impaired during alcohol hangover, with the magnitude of driving impairment being moderated by sleep duration.

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0819

SLEEP AND MELATONIN IN ACTIVELY DRINKING ALCOHOLICS

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Introduction: Approximately 10% of the population drinks alcohol excessively, leading to a significant health burden. We are conducting the

first comprehensive assessment of dim light melatonin timing and plasma melatonin AUC in actively drinking alcoholics to better characterize the relationships between alcohol consumption, sleep and melatonin in this population.

Methods: To date 14 (10 male, 4 female) actively drinking alcoholics (NIAAA Lifetime Drinking, DSM-IV) without liver disease, 23-62 years, have participated in 1 week of wrist actigraphy followed by a 24 hour dim light phase assessment with plasma sampling every hour. All subjects were instructed to abstain from alcohol 24 hours before the phase assessment and passed a breathalyzer test.

Results: The alcoholics fell asleep late (mean 0:55 am) but woke relatively early (mean 7:42 am). Sleep quantity and quality were low, with only 5.6 hours of sleep per night, and only 84% of the sleep interval scored as sleep. The individual variability in sleep timing was high, as on average sleep start and end times varied within a 5 hour window. Greater alcohol consumption was associated with more variability in sleep start time ($r = 0.63$, $p < 0.02$). Average DLMO was at 8:25 pm, indicating the alcoholics fell asleep at a later circadian time. Later average sleep start time was associated with a later DLMO ($r = 0.55$, $p = 0.05$). Melatonin AUC was less than half of that in healthy subjects studied at the same time of year (mean AUC 270.2 vs. 565.6 pg/ml/h, $p < 0.01$). Data collection and analysis is ongoing.

Conclusion: Active alcoholics fall asleep at a relatively late social clock and circadian time. Sleep times are highly variable, and this variability increases with greater alcohol consumption. Melatonin secretion is markedly suppressed in active alcoholics. This poor sleep and circadian hygiene likely contributes to the poor mental and physical health often associated with alcoholism.

Support (If Any): K23 AA019966 to GS.

0820

EVOKED DELTA EEG MARKERS OF BRAIN RECOVERY WITH ABSTINENCE IN LONG-TERM ALCOHOLICS

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Introduction: Amplitude and incidence of evoked K-complexes (KC) are reduced in those with long-term alcohol dependence. Preliminary data have indicated that 12 months of abstinence may be associated with an increase in evoked KC amplitude, which is thought to reflect partial recovery in underlying brain mechanisms. The present study evaluated recovery within the first two months following detoxification in alcohol dependant (AD) participants.

Methods: Participants were 13 controls (46.1 ± 9.5 yrs; 8 men; 62.5 ± 125 kg estimated lifetime alcohol) and 14 AD (41.1 ± 8.2 yrs; 10 men; 152.5 ± 135 kg estimated lifetime alcohol). Sleep EEG was measured on two occasions, one month apart. Baseline for AD was between 8 and 30 days (mean = 17.6 ± 7 days) post detoxification. All AD were drawn from inpatient treatment programs and remained abstinent between recordings. K-complexes evoked by auditory tones presented during NREM sleep were recorded from multiple scalp sites using standard methods. Differences between AD and controls at baseline were assessed with the Mann-Whitney test, and changes over time within each group were assessed using Wilcoxon's signed rank test.

Results: At baseline, AD had smaller KC elicitation rates than controls (AD: $36.3 \pm 13.0\%$; controls: $68.3 \pm 12.0\%$; $p < 0.001$), and smaller KC amplitude at Fz (AD: $-50.3 \pm 19.7 \mu V$; controls: $-92.2 \pm 26.6 \mu V$; $p < 0.001$). Controls did not show significant changes in either KC incidence or amplitude from initial assessment to the one month follow-up (KC%: $59.9 \pm 1.17\%$; KC amplitude at Fz: $-91.3 \pm 36.1 \mu V$). However, one month of abstinence did result in significant increases in both measures for AD (KC%: $49.4 \pm 17.5\%$, $p < 0.01$; KC amplitude at Fz: $-62.3 \pm 26.7 \mu V$, $p < 0.05$).

Conclusion: These results provide evidence, in this relatively young population of alcoholics, of functional brain recovery following one month of abstinence, as assessed by KC incidence and amplitude. These findings support previous research showing improvement in these KC characteristics over twelve months in older alcoholics, and evidence from other lines of research showing MRI measures of structural recovery within one month.

Support (If Any): National Institute on Alcohol Abuse and Alcoholism (AA020565) to IMC.

0821

THE ASSOCIATION OF IGF-1 AND METAL DISORDERS AFTER MILD TRAUMATIC BRAIN INJURY

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Introduction: Mild traumatic brain injury (mTBI) is the one of major public problems and it results in several physical and psychiatric problems, such as headache, fatigue, sleep disturbance or depression. The insulin like growth factor 1 (IGF-1) system is involved in growth and survival signaling in the central nervous system. The aim of our study was to determine the difference of IGF-1 level among the different severity metal disorders following mTBI.

Methods: 101 mTBI patients and 106 healthy participants (control group) were recruited for our observational study. The definition of the metal disorder severity is the number of psychiatric problems, including anxiety (Beck Anxiety Inventory), depression (Beck Depression Inventory II), daytime sleepiness (Epworth sleepiness scale) and sleep quality (Pittsburgh sleep quality index). Five severity groups are no, slight mild, mild, moderate, and severe. The patients' age were divided into three groups, young (< 31 years old), median (31-50 years old), and old (> 50 years old). The association was evaluation via three-way ANOVA and the Tukey multiple comparison of means.

Results: The IGF-1 level of mTBI was significant lower than that of the control group. From the multiple comparisons, the IGF-1 level of the young age group was significantly higher than that of both median age and old age group. In addition, the IGF-1 levels of the moderate and severe problems groups were significantly lower than that of no problem group.

Conclusion: Patients after mTBI had lower IGF-1 level than the control group. Age is also a factor affecting the level of IGF-1. Moreover, the mTBI Patients with severe metal disorder had lower IGF-1 level than the control group.

0822

RELATIONSHIP OF NEUROTICISM TO RETROSPECTIVE AND ACTIGRAPHICALLY MEASURED SLEEP QUALITY AND CHRONOTYPE

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Introduction: Others have reported that delayed sleep phase syndrome patients show elevated neuroticism on the NEO-Personality Inventory-Revised (NEO-PI-R) and that higher neuroticism on the NEO Five-Factor Inventory predicts poorer scores on the Pittsburgh Sleep Quality

Index (PSQI). We administered the NEO-PI-R with both subjective and objective measures of sleep quality and chronotype.

Methods: 96 healthy males wore the Actiwatch2 making event marks when beginning to attempt sleep and waking for the day. 93 individuals (aged 18-29, mean 20.9, SD 2.7) provided usable NEO-PI-R answer sheets, 91 completed the Epworth Sleepiness Scale (ESS), PSQI and Morningness-Eveningness Questionnaires (MEQ), and 85 individuals produced 4-9 usable actigraphy nights (mean 7.0, SD 1.0, 91% > 5 nights, 86% > 6). Participants wore Actiwatch 7-9 days during which they were asked to abstain from naps, recreational drugs and alcohol, go to bed before 2 AM and allow a minimum 7-hr sleep opportunity. Using event-mark anchors (and diary entries when missed), sleep's total time (TST), onset latency (SOL), efficiency (SE) and midpoint (between sleep onset and waking event mark) were calculated. Midpoint served as a binary proxy for Chronotype ("Owls" vs. "Larks") using a median split of minutes past midnight. NEO-PI-R neuroticism scores were similarly split to form High vs. Low neuroticism groups.

Results: Midpoint significantly correlated with MEQ ($R = .38$, $p = .0006$). High, compared to Low, neuroticism was associated with elevated ESS [$F(1,89) = 7.45$, $p = .008$] and PSQI [$F(1,89) = 6.65$, $p = .012$], and lower MEQ morningness [$F(1,89) = 13.76$, $p = .0004$]. Similarly, neuroticism scores were positively correlated with ESS ($R = .26$, $p = .013$), PSQI ($R = .39$, $p < .0001$) and negatively with MEQ morningness ($R = .43$, $p < .0001$). High, compared to Low, neuroticism was associated with lower SE [$F(1,79) = 4.08$, $p = .047$] and a later midpoint [$F(1,79) = 4.33$, $p = .041$]. Similarly, Owls showed a trend toward greater neuroticism [$F(1,79) = 3.24$, $p = .076$] compared to Larks.

Conclusion: Greater neuroticism scores predict poorer sleep and greater eveningness as measured both by retrospective questionnaires and objective (actigraphic) measures.

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0823

THE ASSOCIATION BETWEEN NIGHTMARES AND SUICIDE RISK IS CROSS-SECTIONALLY MEDIATED BY BORDERLINE SYMPTOMS

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Introduction: Research has demonstrated that nightmares are associated with suicidal ideation, attempts, and death by suicide. Further, the association between nightmares and suicidal ideation and attempts remains significant even after controlling for PTSD, depression and anxiety symptoms. To date, the mechanism by which nightmares confer suicide risk is still unclear. To address this gap, the present study investigated whether the relation between nightmares and suicide risk was mediated by borderline personality symptoms. We hypothesized that nightmares would be associated with suicide risk when accounting for symptoms of borderline personality disorder.

Methods: 375 college students enrolled at large-grant Southeastern public university were recruited for the current study. Nightmares were measured by the Disturbing Dream and Nightmare Severity Index, suicide risk by the Suicidal Behaviors Questionnaire-Revised, and borderline personality symptoms by the Borderline Symptom List-23.

Results: Results of simple linear regression showed that nightmares ($\beta = .285$, $p = .00$) and borderline personality symptoms ($\beta = .572$, $p = .00$) are both significantly associated with suicidal ideation. The mediation analysis was conducted using Process (Hayes, 2013). As indexed by the bias corrected confidence interval, there is a significant indirect effect of nightmares through borderline personality symptoms, $b = .019$, $SE = .003$ BCa CI [.0129, .0259]. Moreover, nightmares were no longer associated with suicidal risk when borderline personality symptoms were accounted for, $b = .005$, $SE = .004$ BCa CI [-.0030, .0125]. The

results indicated that borderline personality symptoms mediate the relation between nightmares and suicide risk.

Conclusion: Our findings suggest that nightmares exert their effects on suicide risk indirectly through enhancing borderline personality symptoms. Future research is needed to attempt to replicate and extend this finding, as well as to investigate whether facets of borderline personality disorder, such as emotional dysregulation, are associated with nightmares and contribute to suicide risk.

0824

RELATIONSHIPS BETWEEN OBJECTIVE AND SUBJECTIVE SLEEP MEASURES AND EMOTION REGULATION IN PATIENTS WITH ANXIETY DISORDERS

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Introduction: Sleep quality impacts mood and emotion regulation. Patients with mood disorders such as depression exhibit emotion dysregulation and poor sleep quality, including insomnia which do not relate to subjective ratings of sleep. However, less is known about sleep and its effects on emotion regulation in anxiety disorders. This study evaluated the relationship between sleep and emotion regulation in anxious patients, via Reappraisal and Suppression, the former considered to be an adaptive, optimal regulation strategy.

Methods: As part of a larger study, objective and subjective sleep measures were collected from 17 patients with social phobia, generalized anxiety disorder, or panic disorder using actigraph and sleep logs to record sleep-wake patterns and sleep disturbances for 7 nights/8 days. Sleep indexes included total sleep time, sleep efficiency, and overall sleep quality ratings. Reappraisal and Suppression strategies were examined with the Emotional Regulation Questionnaire.

Results: On average, patients slept 6.34 ± 0.89 hours per night indicative of shorter sleep duration than typically shown in healthy individuals. Consistent with previous studies, there was no relationship between objective and subjective sleep measures. Here, patients tended to overestimate sleep duration. Among sleep measures, a positive correlation between objective total sleep length and Reappraisal emerged, ($p < 0.05$). No correlations were observed for Suppression.

Conclusion: Anxiety patients' ratings of sleep quality were unrelated to actual sleep length or efficiency. Findings highlight the importance of using objective sleep measures when studying sleep quality in anxiety disorders, which may be of therapeutic value. Reappraisal, an adaptive emotional regulation strategy, was shown to positively correlate with objective sleep length. Suggesting that patients who sleep more hours per night are better able to employ a regulation strategy that is associated with healthy functioning or the ability to utilize Reappraisal may contribute to optimal sleep duration.

0825

TRANSCRANIAL LIGHT EXPOSURE ACUTELY ALLEVIATES ANXIETY SYMPTOMS: A RANDOMIZED, SHAM-CONTROLLED, DOUBLE-BLIND TRIAL

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Introduction: Bright light exposure has been found to have acute anxiolytic effects in patients suffering from Seasonal Affective Disorder (SAD) and subjects reporting low anxiety symptoms. In addition, a sham-controlled study in highly anxious young adults showed favorable results comparing the bright light treatment with an inactivated negative ion generator, albeit not significant. Transcranial bright light seems to

alleviate depressive symptoms of patients suffering from SAD. Hence depression and anxiety commonly co-occur and share neurochemical features, it is reasonable to expect that transcranial bright light might also have anxiolytic effects.

Methods: Twenty-eight participants (F = 19, M = 9, mean age \pm SD: 44 ± 14 years) with moderate anxiety and depressive symptoms (Beck Anxiety Inventory, BAI total score = 19 ± 9 ; Beck Depression Inventory, 2nd ed., BDI-II total score = 21 ± 9) were randomly assigned to either 12 minutes of acute transcranial bright light or sham exposure (double-blind) under laboratory conditions in the morning between 9 am and 12 pm. Anxiety symptoms were measured using the Spielberger State-Trait Anxiety Inventory (STAI, form Y1) self-rating questionnaire 5 minutes prior and 10 minutes after the exposure.

Results: Mean anxiety symptoms (STAI-Y1 score) in the transcranial light group decreased by $12.1 \pm 7.3\%$ from 43.7 ± 2.0 to 38.1 ± 1.4 ($p < 0.001$), whereas symptoms in sham-control group reduced non-significantly by $3.7 \pm 11.3\%$ from 45.6 ± 2.2 to 43.4 ± 1.7 ($p = 0.115$). P-values for relative and absolute difference between groups regarding mean STAI-Y1 scores were 0.024 and 0.048, respectively.

Conclusion: This is the first randomized, sham-controlled transcranial light study, which shows that transcranial bright light acutely alleviates anxiety symptoms. Further clinical studies on long-term efficacy of transcranial bright light treatment on anxiety symptoms are called for.

Support (If Any): This study was supported by Valkee Ltd and the Finnish Funding Agency for Technology and Innovation.

0826

THE ROLE OF CHILDHOOD TRAUMA AND POSTTRAUMATIC STRESS DISORDER IN POSTPARTUM SLEEP DISTURBANCE

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Introduction: Among factors that may influence sleep in the postpartum period, little is understood about the role of childhood trauma, which is known to negatively affect sleep in non-perinatal adults. We investigated sleep complaints in postpartum women with a history of childhood trauma relative to postpartum women without a history of childhood trauma, with a focus on the contribution of posttraumatic stress disorder (PTSD).

Methods: At four months postpartum, 173 women completed a psychiatric assessment (including lifetime and current diagnosis of PTSD) and the Childhood Trauma Questionnaire by telephone. Questions regarding sleep included: "you woke up on your own in the middle of the night and had trouble getting back to sleep" and "you tossed and turned for a long time trying to fall asleep." Participants who indicated that they "agreed" or "strongly agreed" with these items were categorized as experiencing difficulty in that sleep domain.

Results: After adjusting for covariates, logistic regressions indicated that childhood neglect and physical abuse were associated with increased odds of difficulty with falling (OR = 4.14 and 4.97, respectively; $ps < .05$) and staying asleep (OR = 6.02 and 4.85, respectively; $ps < .05$). Sexual abuse, however, was not associated with an increased risk of sleep complaints. Comparable rates of sleep disturbance were observed between women without a history of childhood trauma and those who reported a history of childhood trauma but never met criteria for PTSD. A past history of PTSD was associated with difficulty falling (OR = 4.66, $p < .05$) or staying asleep (OR = 4.15, $p < .05$) relative to women without a history of childhood trauma. Women with a history of childhood trauma and current PTSD had the greatest odds of reporting difficulties with falling (OR = 13.95, $p < .05$) and staying asleep (OR = 11.91, $p < .05$).

Conclusion: These findings suggest that sleep problems in postpartum women may be exacerbated by childhood trauma, particularly in women with current or past PTSD.

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0827

SLEEP DISTURBANCES DIFFERED AMONG OBSESSIVE-COMPULSIVE DISORDER PHENOTYPES

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Introduction: Existing studies suggested that sleep problems were common among obsessive-compulsive disorder (OCD). However, whether the sleep profile is consistent across different OCD phenotypes requires clarification. The current study aimed to explore if sleep characteristics differed across OCD phenotypes.

Methods: Eighty-three young adults (aged 18 to 23, 51 female) completed a 5-day sleep diary and reported daily sleep characteristics (sleep duration, sleep onset latency and wake after sleep onset); the Pittsburgh Sleep Quality Index (PSQI) (a global score > 5 indicates poor sleepers); the Dysfunctional Beliefs and Attitudes about Sleep questionnaire (DBAS) which assessed sleep-disruptive cognitions; the Epworth Sleepiness Scale (ESS) which measured daytime sleepiness and the Obsessive Compulsive Inventory – Revised (OCI-R) the Obsessive-Compulsive Inventory – Revised (OCI-R), which measured symptoms of six OCD phenotypes (hoarding, neutralizing, obsessing, washing, checking and ordering).

Results: PSQI global score was positively correlated with OCI-R total score ($r = .23$, $p = .05$); and subscales including obsessing ($r = .26$, $p = .02$); neutralizing ($r = .22$, $p = .05$); and hoarding ($r = .22$, $p = .05$). Hoarding subscale was also positively correlated with sleep onset latency ($r = .23$, $p = .05$) and wake after sleep onset ($r = .23$, $p = .05$). DBAS was positively correlated with OCI-R total score ($r = .28$, $p = .01$); hoarding ($r = .28$, $p = .01$); ordering ($r = .24$, $p = .03$); washing ($r = .28$, $p = .01$) and neutralizing ($r = .32$, $p = .05$).

Conclusion: Our findings demonstrated most OC phenotypes possess dysfunctional beliefs about sleep, while only specific phenotypes manifest sleep disturbances. Specifically, individuals with hoarding behaviors appeared to have the greatest number of sleep disturbances. Our findings suggested that sleep problems were associated with OCD symptoms. We further showed that sleep problems might differ across OC phenotypes. Researchers and practitioners should be noted of the specific sleep problems in OC patients with different phenotypic expression.

0828

THE IMPACT OF EATING DISORDERS ON SLEEP AND DAYTIME FUNCTIONING

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Introduction: Sleep disturbances are commonly reported in patients with eating disorders. The aim of this study was to investigate the effects of eating disorders and body mass index (BMI) on sleep disturbances and daytime functioning.

Methods: A survey was conducted among Dutch young adults (18 to 35 years old) to collect data on eating habits, sleep quality and sleep duration. Information on weight and height enabled computing of the BMI. The Eating Disorder Screen for Primary Care (EPS) and SLEEP-50 subscales on sleep apnea, insomnia, circadian rhythm disorder (CRD) and daytime functioning were completed. BMI, EPS, and SLEEP-50 scores were compared using correlational analyses. Subjects with eating disorder

ders (EPS score > 2) were compared to those without eating disorders (EPS score < 2).

Results: N = 574 subjects (mean age 22.3 years old; 68.5% women) completed the survey. Only a few of the subjects met the SLEEP-50 criteria for insomnia (N = 9), sleep apnea (N = 1), or CRD (N = 3). N = 68 (11.8%) subjects were classified as having eating disorders. Out of the total sample N = 14 (2.4%) of subjects reported having uncontrolled nocturnal eating episodes. Significant correlations were found between EPS scores and scores on insomnia ($r = 0.158$, $p = 0.0001$), sleep apnea ($r = 0.131$, $p = 0.002$), and daytime functioning ($r = 0.249$, $p = 0.0001$), but not for CRD ($r = 0.07$, $p = 0.092$). BMI scores only correlated significantly with scores on sleep apnea ($r = 0.165$, $p = 0.0001$). A clear difference in sleep disturbance scores was found between those with and without eating disorders. Subjects with eating disorders reported significantly higher scores on sleep apnea (2.9 versus 3.7, $p = 0.011$), insomnia (5.5 versus 7.7, $p = 0.0001$), CRD (2.3 versus 2.9, $p = 0.009$), and impairment of daytime functioning (5.8 versus 8.8, $p = 0.0001$) relative to subjects without eating disorders.

Conclusion: Subjects with eating disorders commonly experience sleep disturbances and impairment of daytime functioning. The relationship between sleep disturbances and BMI was less clear.

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0829

SLEEP IN YOUTH WITH BIPOLAR DISORDER

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Introduction: Sleep disturbances, including insomnia, hypersomnia, and reduced need for sleep, are common in bipolar disorder (BP), during episodes of mania, depression, and in the interepisode period. Less is known about sleep in pediatric bipolar disorder. We examined baseline sleep diary and actigraphy data in youth with bipolar spectrum disorders (BP I, II, or operationalized criteria for NOS) who are being prospectively followed for a year.

Methods: Participants included youth ages 13-22 with bipolar disorder ($n = 30$) and age-matched controls ($n = 30$). Half of the bipolar sample was currently depressed according to clinician ratings. Participants completed daily sleep diaries and wrist actigraphy for 10 days (85% of the sample had 8 or more days of data). Mixed models were used to examine sleep outcomes across three groups (euthymic BP, depressed BP, and control), controlling for age, weekend vs. weekday, and a lag of the outcome variable to adjust for autocorrelation. We also examined the impact of sleep on waking mood ratings on the sleep diary (Visual Analog Scale ratings from Very Calm to Very Tense).

Results: Significant group differences were found for total sleep time (TST) for both actigraphy ($F = 10.25$, p euthymic > control) and sleep diary ($F = 4.56$, $p = 0.011$; depressed > control); wake after sleep onset for actigraphy ($F = 3.31$, $p = 0.037$; euthymic > control); and self-reported morning mood and sleep quality ($F = 26.82$, $p < 0.001$ and $F = 26.31$, p euthymic > control). Unexpectedly, bedtimes were significantly later in controls compared to the euthymic and depressed bipolar sample combined. ($F = 4.7$, $p = 0.031$; bipolar < control). A curvilinear association was found for sleep diary TST and morning mood ($t = 2.08$, $p = 0.039$).

Conclusion: The bipolar sample, particularly in those who were depressed, had greater amounts of sleep, poorer sleep quality and poorer mood. Sleeping too little or too much was associated with lower mood reports in the morning. Regularizing sleep duration may help improve mood and functioning in youth with bipolar disorder who are currently depressed.

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0830

SLEEP AND DAYTIME COMPLAINTS DURING MANIA AND DEPRESSIVE EPISODES IN CHILDREN AND ADOLESCENTS WITH BIPOLAR DISORDER

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Introduction: Sleep complaints are frequently described in bipolar disorder (BD). However, there are few data about sleep and symptomatic daytime behaviors during childhood. The aim of this study was to describe the presence of sleep and daytime complaints in children and adolescents with BD.

Methods: Our sample was composed by 72 subjects who were diagnosed with BD. The data were obtained from two research databases of patients consecutively referred for BD treatment in an outpatient clinic. Mood psychopathology was ascertained by face-to-face clinical interview and by the Diagnostic Interview for Children and Adolescent DSM-IV version (DICA-IV). We applied sleep questionnaires where we obtained their sleep and daytime complaints, during mania and depressive episode. All statistical tests of significance were done using 2 tailed tests with $\alpha = 0.05$.

Results: Our patients in this study were 29 children (age = 10 ± 3 y, boys = 23) and 43 adolescents (age = 15 ± 2.4 y, boys = 30). The occurrence of SC was observed in 66.4% during mania and in 52.3% during depressive episode. There were 37.9% patients with SC in both episodes. The time in bed was higher during depressive episode when compared with mania episode ($p = 0.01$). Interestingly, we found an increase of the presence of nocturnal enuresis in depressive episode when compared with mania episode ($p < 0.05$). Also, the energy during daytime after a sleep disturbance was higher during both episodes ($p < 0.05$), and unrested sleep was higher in adolescents in their both episodes, and it was statistically significant during mania episode ($p < 0.05$).

Conclusion: Our patients showed a strong association among sleep and daytime complaints. The daytime complaints may increase some symptomatic behaviors in these patients, such as agitation, irritability or other. The relationship between sleep and daytime complaints in children and adolescents with BD is still unclear. Further research is necessary to understand the implication of this data.

0831

CHANGE IN 24 HOUR LIGHT EXPOSURE PATTERNS IN PATIENTS WITH BIPOLAR DEPRESSION

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Introduction: Circadian rhythm disturbances are thought to play a role in bipolar depression. Specifically it has been suggested that alterations in circadian rhythms increase the risk for relapse of bipolar disorder, and both the timing and intensity of light exposure could play a crucial role. This study compared 24-hour light exposure patterns in adult patients with bipolar disorder in depressed (DS) vs. remitted state (RS).

Methods: Five bipolar patients (1M, 4F, mean age: 35.2 yrs, age range: 24-49 yrs) were assessed twice once each during DS and RS states. Measures during each assessment included 24 h distribution of light and activity level and sleep wake patterns determined using a wrist light/

activity monitor (AW-L) for 7 consecutive days. Home-based salivary melatonin samples were collected by participants starting 4.5 hour prior to habitual bedtime. Dim light melatonin onset (DLMO) 3pg and 2SD were calculated. Acrophase and amplitude of 24-hour light exposure pattern were computed by non-linear regression.

Results: There was no significant difference in sleep wake parameters (bedtime, wake time, sleep latency, total sleep time, sleep efficiency) between DS and RS. Melatonin onset was advanced in DS ($n = 3$, DLMO 3pg: DS = 20.8 ± 1.3 h, RS = 21.3 ± 1.5 h; DLMO 2SD: DS = 19.9 ± 1.5 h, RS = 20.5 ± 0.9 h), and DS showed an increased phase angle between DLMO2SD and acrophase of light exposure compared to RS ($n = 3$, DS = 8.1 ± 1.2 h, RS = 7.6 ± 1.4 h). For the 24 h light exposure profiles, acrophase was significantly advanced (DS = 13.0 ± 0.5 , RS = 13.7 ± 0.2 , $p = .04$), and amplitude was significantly reduced in DS (DS = 1.8 ± 0.3 , RS = 2.7 ± 0.5 , $p = .04$).

Conclusion: During a depressive episode bipolar patients had both an earlier timing and lower amplitude of light exposure. These changes in light exposure were also associated with changes in the phase relationship between light and melatonin. These results suggest that bipolar depression could be related to circadian rhythm disturbance and a change in 24 h-light exposure patterns could contribute to the pathophysiology of bipolar depression.

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0832

THE RELATIONSHIP BETWEEN STAGE 2 SLEEP AND IQ IN AUTISTIC AND TYPICALLY DEVELOPING CHILDREN

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Introduction: EEG sleep spindle activity correlates with IQ in typically developing individuals (TYP). Sleep spindles are diminished in autism. We investigated whether the relationship between IQ scores and sleep spindles activity differed in children with autism compared to typically developing children.

Methods: Thirteen boys with high functioning autism (HFA: 10.2 ± 2.1 years) and 13 comparison children (COM: 10.2 ± 2.0 years) were recorded for two consecutive nights. IQ was determined by administering the WISC-III in the morning after night 2. Sleep spindles activity and sigma EEG power (slow: 12-13 Hz; fast: 13.25-15.75 Hz) were computed for frontal (Fp1, Fp2) and central (C3, C4) electrodes during Stage 2 sleep. Results from the two groups were compared and correlations between EEG measures and IQ were tested using Pearson's rho ($\alpha = .05$).

Results: There were no significant group differences on IQ (HFA: Global = 105.2 ± 18.7 , Performance = 106.2 ± 13.0 , Verbal = 103.8 ± 22.3 ; COM: 115.8 ± 10.3 , 114.1 ± 12.1 , and 115.1 ± 12.8 , respectively). Spindle density (no/hour stage 2) was lower in the HFA than in the COM group at the Fp2 electrode (669.7 ± 467.3 and 126.8 ± 87.1 vs. 1018.8 ± 466.4 and 216.2 ± 121.2 , respectively). The HFA group showed a significant, negative correlation between C3 spindle density in the first quarter of the night and the global ($r = -0.52$) and verbal ($r = -0.62$) IQ scales. The COM group showed a negative correlation between spindle density and verbal IQ at the Fp2 electrode. The duration of sleep spindles was shorter in the HFA group compared to COM at the Fp1 electrode. Duration of sleep spindles at C4 was positively correlated with verbal IQ only in COM. Fast sigma power was significantly lower in the HFA than the COM group for C3 and C4 electrodes in the last quarter of the night (HFA: C3 = 0.925 ± 0.096 , C4 = 0.650 ± 0.226 ; COM: C3 = 1.06 ± 0.18 ,

C4 = 0.888 ± 0.301). Only the control group showed a positive correlation between global IQ and C4 fast Sigma activity in the last quarter of the night ($r = 0.592$).

Conclusion: These results are consistent with a relation between stage 2 sleep EEG and cognitive processing in typically developing children. Results in autistic children differed, suggesting an atypical relationship between sleep EEG activity and information processing in this population. Further analyses with more scalp locations and spectral analysis of sleep spindle are under way in order to better characterize this sleep EEG/IQ relationship.

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0833

SLEEP DISTURBANCES IN CHINESE CHILDREN WITH AUTISM SPECTRUM DISORDERS: CHARACTERISTICS AND ASSOCIATED FACTORS

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Introduction: To describe sleep disturbances in Chinese children with autism spectrum disorders (ASDs), and examine the association between socio-demographics, emotional and behavioral problems and sleep disturbances.

Methods: Parents of 64 children with ASDs (6-17 years) recruited from a special school in Shenzhen, China completed validated Chinese Children's Habits (CSHQ) and Strengths and Difficulties Questionnaires (SDQ).

Results: Seventy percent of the children were found to have global sleep disturbances (defined as a CSHQ total score > 41). From most to least prevalent problems were: short sleep duration (40.0%), bedtime resistance (33.3%), sleep anxiety (26.7%), sleep onset delay (21.7%), sleep disordered breathing (21.7%), night waking (16.7%), and daytime sleepiness (15.0%). Correlation coefficient between total scores of CSHQ and SDQ was 0.51, and attained significant level ($p < 0.01$). Hierarchical multiple regression revealed that being a girl ($\beta = 0.36$, $p < 0.01$), higher parental age ($\beta = 0.71$, $p < 0.01$), more severe hyperactivity ($\beta = 0.54$, $p < 0.05$) and lower prosocial behavior ($\beta = -0.40$, $p < 0.01$) explained significant variance in the CSHQ total score.

Conclusion: Chinese children with ASDs display various sleep disturbances of comparable severity and prevalence to their American counterparts. Such problems are associated with multiple child and family factors. These findings highlight the importance of screening and treating sleep disturbances in Chinese children with ASDs.

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0834

SENSORY-MOTOR PROCEDURAL MEMORY AND EEG SLOW-WAVE ACTIVITY DURING NONREM SLEEP IN YOUNG TYPICAL AND AUTISTIC ADULTS

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Introduction: People with autism spectrum disorder (ASD) perform poorly on sensory-motor procedural tasks. Stage 2 sleep and Slow Wave Sleep (stages 3+4: SWS) are linked to sensory-motor procedural learning while EEG slow-wave activity (SWA) during nonREM sleep is thought to reflect formation of new memories. We verified if a relation exists between SWA activity and sensory-motor procedural learning in ASD and typically developed (TYP) adults.

Methods: The sleep of 13 ASD and 14 TYP participants (22.1 ± 3.8 and 21.5 ± 3.6 years old, respectively) was recorded in a laboratory for 2 consecutive nights using a 22-electrode EEG montage. All had a normal IQ, none complained of poor sleep and none were taking medications. Spectral analysis of Delta (0.75-3.75 Hz) EEG activity was obtained for stage 2 and SWS. A sensory-motor procedural task (Rotary Pursuit) was administered the morning following night 2. Learning and performance indices (i.e., improvement of performance across trials and average performance for all trials, respectively) were calculated. Correlation analyses tested the association between Delta EEG power during nonREM sleep and learning/performance. Significance was set to 0.05.

Results: The TYP group displayed a significant positive correlation between the learning index and Delta power during stage 2 sleep all over the scalp and during SWS for the frontal and left temporal regions. The ASD group displayed a significant positive correlation between the learning index and stage 2 Delta power within the frontal and the left temporal regions but no significant correlation was found with Delta power during SWS. A significant positive correlation was found between the performance index and Delta power during stage 2 in the ASD group only.

Conclusion: Delta activity during nonREM sleep is associated with better learning of a sensory-motor procedural task in TYP as well as in ASD groups of participants. Delta activity, however, is positively associated with performance only in ASD. These results suggest that sensory-motor procedural learning and performance of people with ASD do not rely on the exact same neuronal networks than TYP participants.

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0835

GENETIC VARIATION IN MELATONIN PATHWAY ENZYMES IN INDIVIDUALS WITH AUTISM SPECTRUM DISORDER AND COMORBID SLEEP ONSET DELAY

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Introduction: Sleep disruption is common in individuals with autism spectrum disorder (ASD). Genetic factors play a role in the etiology of sleep disorders, and in ASD. Genes whose products regulate endogenous melatonin not only modify human sleep patterns, but have also been implicated in ASD. However, there are major challenges replicating effects related to these genes. Underlying genetic differences likely contribute to variable expression of sleep disorders in a proportion of ASD patients. Focusing on comorbid expression of sleep onset delay in

ASD may help us better understand the relationship between variation in melatonin pathway genes and expression of sleep problems in ASD. Our hypothesis is that individuals with ASD and comorbid sleep onset delay will harbor a greater load of variation in genes related to maintenance of endogenous melatonin levels than individuals without evidence of sleep disorders.

Methods: We evaluated genetic variation in two genes, acetylserotonin O-methyltransferase (ASMT) and cytochrome P450 1A2 (CYP1A2), coding for important enzymes in the melatonin pathway in individuals with ASD and sleep onset delay. We compared our results to those reported for individuals with ASD without reported sleep disorders, and/or normal populations of European ancestry.

Results: We observed higher frequencies ($p < 0.04$) for combinations of genotypes at single nucleotide polymorphisms (SNPs) evidenced to decrease ASMT expression. We also observed substantially higher frequencies ($p \leq 0.0007$) for variant alleles related to decreases in CYP1A2 enzymatic activity. We detected a potential relationship between genotypes at a functional SNP in the 5'-untranslated region of ASMT and a functional SNP in the promoter region of CYP1A2 ($r^2 = 0.63$).

Conclusion: Our results indicate that, in individuals with ASD, sleep onset delay may be related to variation in melatonin pathway genes. Our findings also implicate a mechanism connecting lower levels of ASMT transcript production with reduced CYP1A2 metabolic activity in individuals with ASD and comorbid sleep onset delay.

Support (If Any): Burry Chair in Cognitive Development, Vanderbilt University.

0836

IS POSTOPERATIVE DELIRIUM ASSOCIATED WITH SLEEP DISTURBANCE IN PATIENTS AT RISK FOR OBSTRUCTIVE SLEEP APNEA?

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Introduction: Disturbed sleep is a well-established feature of post-operative delirium. Patients with obstructive sleep apnea (OSA) are at increased risk for delirium and often experience disturbed sleep from either their condition and/or from continuous positive airway pressure (CPAP) treatment. Given this high rate of sleep disturbance and the subsequent alterations in sleep/wake physiology that occur, it is possible that sleep disturbance may not be a useful marker for postoperative delirium in OSA patients.

Methods: 59 patients at risk for OSA (STOP-BANG score > 2) undergoing elective hip and knee replacements, roughly half of whom were treated acutely with auto-titrating CPAP, were assessed for delirium on post-operative day two using the Confusion Assessment Method and the Delirium Rating Scale-R-98 (DRS-R-98). Ratings of sleep-wake cycle disruption on the DRS-R-98 (scored 0-3, with 3 indicating greatest disruption) were compared between delirious and non-delirious patients.

Results: Sleep-wake cycle ratings were significantly higher in patients with delirium (mean 1.89 ± 0.6 , $n = 9$) than in patients without delirium (mean 1.18 ± 0.77 , $n = 50$, $p = 0.0043$) when adjusting for age and CPAP use. There was no significant difference in sleep-wake cycle ratings between patients as a function of CPAP use. In patients who used CPAP postoperatively, the number of nights of CPAP use, total hours of use, apnea-hypopnea index, and CPAP pressure did not correlate with sleep-wake cycle ratings.

Conclusion: This study confirms that the presence of disturbed sleep is associated with the occurrence of post-operative delirium in OSA patients. However, our data suggest that post-operative auto-titrating CPAP use neither improves nor worsens patient-reported sleep. Furthermore, post-operative CPAP use does not alter the relationship between sleep-

wake cycle disturbance and delirium. Further work is needed to measure and characterize the specific nature of the sleep-wake disruption in delirious patients with OSA.

0837

DOES THE DRS-R-98 SCALE ACCURATELY REFLECT POSTOPERATIVE DELIRIUM IN PATIENTS AT RISK FOR OBSTRUCTIVE SLEEP APNEA?

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Introduction: Postoperative delirium (POD) is common and associated with significant adverse consequences. Recent evidence suggests that obstructive sleep apnea (OSA) is a risk-factor for POD. However, the accuracy of delirium rating scales in OSA patients is unknown and may vary from the general population because of the sleep and cognitive effects of OSA. Here we evaluated the Delirium Rating Scale-Revised-98 (DRS-R-98), a 13-item scale based on behavior over a 24 hour period versus the Confusion Assessment Method (CAM) where a clinician makes a dichotomous judgment of whether delirium is present based on all available information. We sought to determine if the DRS-R-98 is sensitive and specific compared with clinical judgment in identifying delirium in postoperative OSA patients.

Methods: Patients at risk but untreated for OSA (STOP-BANG score > 2) and scheduled to undergo elective knee/hip replacements were prospectively enrolled. Delirium was assessed on postoperative day 2 using both DRS-R-98 and CAM.

Results: Sixty subjects underwent assessment. The mean DRS-R-98 in CAM+ patients was 9.6 ± 1.7 and in CAM- patients was 3.4 ± 0.3 (odds ratio: 1.68, 95% C.I.: 1.23-2.29). With the recommended cutoff for delirium of 16 points, low agreement was obtained (Kappa = 0.16, 95% C.I.: -0.11-0.43) with 20% sensitivity and 100% specificity. In contrast, a score cutoff of 9 (optimized using receiver operator curve analysis) has 70% sensitivity, 98% specificity and Kappa = 0.74 (95% C.I.: 0.50-0.98).

Conclusion: This analysis suggests that the DRS-R-98 with the recommended cutoff of 16 has unacceptable reliability compared to CAM clinical assessment when used to identify POD in OSA patients. However, the reliability and sensitivity are substantially increased using a cutoff of 9. This suggests that a different DRS-R-98 cutoff may be needed in OSA patients and that delirium assessment may be affected by the presence of OSA.

0838

SLEEP SPINDLE DEFICIT IN FIRST DEGREE RELATIVES OF PATIENTS WITH SCHIZOPHRENIA

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Introduction: Chronic medicated patients with schizophrenia have marked reductions in sleep spindle activity and sleep-dependent memory consolidation, and these deficits are correlated. As prior studies included only chronic medicated patients, it is unclear whether the spindle and memory deficits are due to schizophrenia or its treatment and whether they predate the onset of illness.

Methods: We compared Stage 2 sleep spindle activity in 19 children and siblings of schizophrenia patients (age 14 ± 4 , 9M) and 12 healthy

controls (age 15 ± 5 , 7M). Polysomnography was recorded in a sleep lab for two nights at electrode C4. Data from the second night were analyzed.

Results: Relatives showed reduced wake time after sleep onset ($p = .03$) and reduced sleep efficiency ($p = .04$) compared to controls. Although the reduced spindle density in relatives did not reach significance (1.52 ± 0.29 vs. 1.72 ± 0.33 ; $p = .09$), relatives showed significant reductions in both low (12-13.5 Hz, $p = .01$) and high (13.5-15 Hz, $p = .007$) sigma power, which corresponds to the frequency of sleep spindles. They also showed reduced amplitude ($p = .005$) and sigma power ($p = .003$) of individual spindles.

Conclusion: Individuals at genetic high risk for schizophrenia have significant reductions in sleep spindle activity compared to healthy controls. This raises the possibilities that the spindle deficit predates the onset of schizophrenia and is a genetic risk factor. Deficient sleep spindles may reflect the pathophysiology that gives rise to schizophrenia and are a potential target for preventative intervention.

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0839

SLEEP SPINDLE DEFICIT IN EARLY COURSE, ANTIPSYCHOTIC-NAÏVE PATIENTS WITH SCHIZOPHRENIA

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Introduction: Chronic medicated patients with schizophrenia have marked reductions in sleep spindle activity and sleep-dependent memory consolidation, and these deficits are correlated. As prior studies only include chronic medicated patients, it is unclear whether the spindle and memory deficits are due to schizophrenia or its treatment and whether they are present early in the course of illness.

Methods: We compared Stage 2 sleep spindle density in 26 antipsychotic-naïve patients newly diagnosed with psychosis (age 27 ± 7 , 17M) and 25 healthy controls (age 27 ± 7 , 16M). Polysomnography was recorded in a sleep lab for two nights at electrode C4. Data from the second night were analyzed.

Results: Patients showed reduced total sleep duration ($p = .02$), increased Stage 2 sleep ($p < .001$), reduced slow wave sleep ($p < .001$), reduced sleep efficiency ($p < .001$) and reduced spindle density ($p < .05$) relative to controls. The spindle density reduction was attributable to the subset of patients diagnosed with schizophrenia ($n = 15$; 1.22 ± 0.48) who differed significantly from both controls (1.64 ± 0.32 ; $t(38) = 2.78$, $p = .002$) and non-schizophrenia patients ($n = 9$; 1.68 ± 0.30 , $t(24) = 2.78$, $p = .01$). The two patient subsets did not differ on any other sleep measure.

Conclusion: Antipsychotic-naïve early course schizophrenia patients have a significant reduction in sleep spindles compared to both healthy controls and other psychotic patients. This implies that the spindle reduction is present early in the course of schizophrenia, is not due to antipsychotic medications, and is not a general feature of psychosis. Rather it may reflect the pathophysiology that gives rise to schizophrenia and is a potential target for intervention to improve cognition.

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0840

ASSOCIATIONS BETWEEN RACE/ETHNICITY, TIMING OF SLEEP AND HYPERTENSION IN A POPULATION-BASED SAMPLE: CHICAGO AREA SLEEP STUDY (CASS)

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Introduction: Previous research found that sleeping at an adverse circadian phase (circadian misalignment) can negatively impact cardio-metabolic function, including elevations in blood pressure. Even minor differences in timing of behaviors have been associated with cardiovascular outcomes, including increased myocardial infarction rates after the daylight savings time change. The goal of this study was to examine whether habitual sleep timing varied among black, white, Hispanic and Asian adults and whether it was associated with prevalent hypertension.

Methods: Men and women aged 35-64 living in the Chicago, IL area were randomly sampled using commercially available telephone listings and invited to participate in the Chicago Area Sleep Study (CASS). Participants wore in-home apnea detection equipment (ApneaLink™) for one night and wrist actigraphs (Actiwatch™) for 7 days. Actigraphy was used to determine sleep start time in participants with AHI < 15 (n = 160 blacks, 113 Asians, 101 Hispanics, 136 whites). Hypertension was identified by either elevated measured blood pressure or medication use.

Results: Mean (SD) sleep start was 00:15 (1:41) for blacks, 23:54 (0:56) for Asians, 00:05 (1:21) for Hispanics and 23:49 (1:17) for whites. After adjusting for age, sex and education, sleep start time was significantly later in blacks compared to whites (beta = 29 minutes, p = .004), but Asians and Hispanics did not differ from whites. Hypertension was identified in 86 (17%) participants. Later sleep start time was significantly associated with prevalent hypertension (OR = 1.31 per hour, p = .01) after adjustment for age, sex, race/ethnicity, education and average sleep duration.

Conclusion: Black participants fell asleep approximately 30 minutes later than whites on average. In addition, a later sleep start time was significantly associated with increased odds of prevalent hypertension. Since blacks are at increased risk of hypertension compared to whites, further investigation into the potential role of sleep timing and circadian disruption on racial/ethnic disparities in hypertension is warranted.

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0841

THE RELATIONSHIP BETWEEN RACE/ETHNICITY AND SLEEP DURATION DEPENDS ON GEOGRAPHIC LOCATION

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Introduction: Sleep duration is associated with health, and this may disproportionately affect minority groups. It is plausible that changing social-environmental factors (e.g., geographic region) would alter these relationships.

Methods: Data from respondents age ≥ 18 from the 2012 Behavioral Risk Factor Surveillance System were used from Alaska (n = 4,092), Kansas (n = 5,646), Nevada (n = 4,429), and Oregon (n = 4,810). Self-reported sleep duration was assessed as total sleep within a typical 24-hour period. Responses were categorized as very short (≤ 4 h), short (5-6 h), normal (7-8 h), and long (≥ 9 h). Race/Ethnicity was categorized as White, Black/African-American, Hispanic/Latino, Asian-American, Native-American/Alaskan-Native, or Other. Population-weighted multinomial regression analyses examined the relationships between race/

ethnicity and sleep duration category, relative to 7-8 h. Analyses were adjusted for age, sex, education, income, body mass index, and smoking.

Results: Across-state results were consistent with previous epidemiological studies, with very short sleep more likely among Black/African-American (OR = 2.56, 95%CI [1.34, 4.89], p = 0.005) and Other (2.16 [1.35, 3.43], p = 0.001) adults, short sleep more likely among Black/African-American (1.89 [1.36, 2.62], p = 0.0001) and Other (1.63 [1.29, 2.0], p = < 0.0001) adults, and long sleep less likely among Asian-American (0.54 [0.29, 0.99], p = 0.048) and more likely among Other (1.42 [1.10, 2.10], p = 0.012) adults, versus White. A significant race*state interaction was found (p < 0.0001). Analyses were then stratified by state. In Alaska, short sleep was more likely among Blacks/African-Americans (2.67 [1.09, 6.55], p = 0.033) and long sleep was more likely among Asian-Americans (2.95 [1.28, 6.80], p = 0.011) versus Whites. In Kansas, very short sleep was more likely among Others (3.55 [1.21, 10.39], p = 0.021), short sleep was more common among Native-Americans/Alaskan-Natives (3.52 [1.47, 8.45], p = 0.005) and Others (2.56 [1.30, 4.76], p = 0.006), and long sleep was more likely among Others (3.61 [1.48, 8.80], p = 0.005). In Nevada, Hispanics/Latinos were less likely to be very short sleepers (0.41 [0.19, 0.87], p = 0.020), short sleep was more likely among Blacks/African-Americans (1.89 [1.18, 3.03], p = 0.008) and Others (2.21 [1.35, 3.62, p = 0.002], and long sleep was less likely among Hispanics/Latinos (0.60 [0.37, 0.97], p = 0.036) and Asian-Americans (0.24 [0.07, 0.86], p = 0.029). In Oregon, very short sleep was more likely among Blacks/African-Americans (9.00 [2.26, 35.85], p = 0.002), Asian-Americans (5.87 [1.07, 32.14], p = 0.041), and Others (2.82 [1.31, 6.09], p = 0.008), short sleep was less likely among Hispanics/Latinos (0.51 [0.30, 0.85], p = 0.010) and more likely among Others (1.51 [1.05, 2.18], p = 0.026), and long sleep was more likely among Others (1.74 [1.07, 2.83], p = 0.026).

Conclusion: Results demonstrated profound differences in the relationship between sleep duration and race/ethnicity, depending on state. This may be due to regional differences in social-environmental factors.

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0842

WHY DO PEOPLE NAP? A FACTOR ANALYSIS OF SELF-REPORTED SLEEP HABITS

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Introduction: Prior research examining reasons why people nap have classified individuals into several groups: appetitive nappers (for enjoyment), prophylactic nappers (in preparation for sleep loss), and replacement nappers (in response to sleep loss). We factor analyzed people's reasons for napping in order to statistically describe the variability in napping preferences.

Methods: Fifty participants (age = 19.64 ± 1.12 years; 62% male) completed a survey of sleep habits and nap preferences. Exploratory principal components analysis reduced reasons for napping into interpretable factors, and items representative of those factors were summed to create indices. Nap preference indices were then correlated with each other and with sleep quality (Buysse et al., 1989), trait daytime sleepiness (Johns, 1991), sleep hygiene (Mastin et al., 2006), and morningness-eveningness (Horne & Östberg, 1976).

Results: Four factors explained a total of 93.93% of the variance in reasons for napping. We have labelled them restorative (to make up for poor nighttime sleep), cognitive (to feel better and more alert), appetitive (because they enjoy napping), and dysregulative napping (due to

shiftwork). Scores on the nap preferences subscales were uncorrelated with each other, except for restorative and cognitive napping ($r = .35$, $p = .01$). People that endorsed restorative napping had worse nighttime sleep quality ($r = .39$, $p = .007$), higher levels of daytime sleepiness ($r = .32$, $p = .03$), and worse sleep hygiene ($r = .38$, $p = .009$). People that endorsed appetitive napping had higher daytime sleepiness ($r = .28$, $p = .05$). There were no other associations between nap preferences and indicators of sleep health.

Conclusion: Using factor analysis, people's reasons for napping match previous theory and are correlated with indicators of sleep health. These results suggest that epidemiological studies of the effect of napping on health would benefit from categorizing participants by their reasons for napping, as these latent variables may moderate the effects.

0843

PREDICTORS OF PERCEIVED INSUFFICIENT SLEEP AMONG HABITUAL SHORT SLEEPERS

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Introduction: Self-reported short sleep duration is associated with many adverse health outcomes. Some short sleepers perceive their sleep as insufficient, whereas others do not. Previous studies have not characterized these groups, which may present different levels of risk.

Methods: Data from respondents (age ≥ 18) from the 2009 BRFSS were used. Number of days/month of insufficient rest or sleep was assessed. Those reporting 0 or 30 were categorized as never-insufficient or always-insufficient, respectively. Sleep duration was assessed as typical sleep per 24 hours; short sleep was defined as ≤ 6 h. Potential factors included age (reference = 80+), sex, race/ethnicity (reference = white), household size (continuous), suburban/rural (reference = urban), education (reference = college), marital status (reference = married), employment type (reference = sedentary), body mass index (reference = normal), days/month of poor physical and mental health (both continuous), overall health (reference = excellent), exercise (reference = none), and emotional support (reference = always). Population-weighted binary logistic regression analyses evaluated unadjusted and adjusted contributions of these factors in predicting always-insufficient status (vs. never-insufficient) among short sleepers. Among respondents, $N = 7,648$ were short sleepers and $N = 7,098$ provided complete data on all variables.

Results: In unadjusted analyses, short sleepers who were always-insufficient were more likely to be younger (18-24: OR = 3.15, $p < 0.0001$; 25-29: OR = 3.67, $p < 0.0001$; 30-34: OR = 4.96, $p < 0.0001$; 35-39: OR = 4.18, $p < 0.0001$; 40-44: OR = 2.37, $p < 0.0001$; 45-49: OR = 1.97, $p = 0.0003$; 50-54: OR = 2.05, $p = 0.0001$; 55-59: OR = 1.73, $p = 0.004$; 60-64: OR = 1.57, $p = 0.017$), report fair (OR = 1.68, $p = 0.001$) or poor (OR = 3.71, $p < 0.0001$) health and more days of poor physical (OR = 1.05/day, $p < 0.0001$) and mental (OR = 1.08/day, $p < 0.0001$) health, live in a larger household (OR = 1.16/person, $p < 0.0001$) or in a rural area (OR = 1.27, $p = 0.039$), report emotional support frequently (OR = 1.90, $p < 0.0001$), sometimes (OR = 2.04, $p < 0.0001$) or rarely (OR = 2.77, $p = 0.0001$), and were less likely to be male (OR = 0.67, $p < 0.0001$), Asian/Other (OR = 0.63, $p = 0.010$), or widowed (OR = 0.52, $p < 0.0001$). In adjusted analyses, this pattern was maintained for younger age groups (18-24: OR = 3.99, $p < 0.0001$; 24-29: OR = 4.31, $p < 0.0001$; 30-34: OR = 5.50, $p < 0.0001$; 35-39: OR = 4.62, $p < 0.0001$; 40-44: OR = 2.48, $p = 0.0001$; 45-49: OR = 1.74, $p = 0.011$; 50-54: OR = 1.76, $p = 0.0052$; 55-59: OR = 1.57, $p = 0.029$), men (OR = 0.065, $p < 0.0001$), Asians/Others (OR = 0.55, $p = 0.003$), poorer physical (OR = 1.05/day, $p < 0.0001$) and mental (OR = 1.06/day, $p < 0.0001$) health, fair health (OR = 1.38, $p = 0.098$), widows (OR = 0.52, $p < 0.0001$), exercisers (OR = 1.34, $p = 0.013$),

unemployed (OR = 0.57, $p < 0.0001$), those with larger households (OR = 1.13/person, $p = 0.001$), and emotional support frequently (OR = 1.82, $p < 0.0001$), sometimes (OR = 1.87, $p = 0.0001$) or rarely (OR = 2.33, $p = 0.0009$).

Conclusion: At the population level, several characteristics distinguished short sleepers who perceived impairment from those who did not. Future studies may discern whether perceived insufficiency in the context of short sleep is a marker of risk.

Support (If Any): K23HL110216, R21ES022931, UL1RR024134.

0844

WHERE DO COMPANION ANIMALS SLEEP?

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Introduction: Pet ownership and the number of pets per household are at the highest level in two decades (2012 APPA data). The AVMA in 2012 reported that dogs are the most popular pets (36.5 % of households) followed by cats (30.4%) and birds (3.1%). These trends raise questions of where pets sleep and whether they disturb their owners' sleep. A 2002 study published in abstract form reported that 52% of patients seen at the Center for Sleep Medicine had pets, 58% of which slept on the bed. Only 1% of pet owners perceived their companion animals to cause inconvenience at night. (Shepard, 2002).

Methods: Between August and December 2013, 110 consecutive patients provided information about pets at night as a part of a comprehensive sleep questionnaire. Questions were incorporated into sleep environmental section asking the type and number of pets. During the subsequent sleep interview, additional information was collected about where the companion animals slept, any notable behaviors and whether the patient was disturbed.

Results: Pet ownership was similar at 46% (51 patients). Households with multiple pets increased markedly at 42% (21). One household had 5 dogs and 1 cat. Issues potentially disturbing the pet owners' sleep included wandering (6), snoring (4), voiding needs (4), whimpering (3), and seizures (2). One patient owned a parrot that consistently squawked at 6 am. A larger number of patients (10%) in 2013 reported annoyance that their pets sometimes disturbed their sleep.

Conclusion: While the majority of patients did not view their pets intolerably disturbing their sleep, in 2012 a higher percentage of patients experienced irritation. This may be related to the larger number of households with multiple pets. Sleep specialists should inquire about companion animals and help patients problem solve about methods to optimize their sleep.

0845

EFFECTS OF BED SUPPORT PROPERTIES ON QUANTITATIVE SLEEP QUALITY IN NORMAL SUBJECTS

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Introduction: The type of mattress an individual sleeps on can impact overall sleep quality. We hypothesized that new support mattresses would improve a person's sleep quality when compared to their older support mattress.

Methods: Twenty subjects (11 [55%] males, 39 ± 10 yrs old, 11 [55%] Caucasians, BMI = 27 ± 5 kg/m²) completed the study. The subjects were healthy with no history of obstructive sleep apnea or alveolar hypoventilation. Subjects had an overnight home sleep test (HST) as an acquaintance night followed within 1 week by a baseline HST in their own bed. The subjects then had their bed changed to a new mattress-1

followed by a HST after 1 week. The beds were then changed to a new mattress-2 and a final HST was performed after 1 week.

Results: Compared to baseline, while there was no difference in sleep latency with mattress-1 (from 18.7 ± 20.2 min to 24.7 ± 31.8 min, p -value 0.33), there was a significant decrease in sleep latency seen with mattress-2 (from 18.7 ± 20.2 min to 7.1 ± 6.3 min, p -value 0.02). While sleep efficiency increased with both mattress-1 and mattress-2 from $83.3 \pm 10.5\%$ to $85.1 \pm 10.6\%$ (p -value 0.57) and $87.9 \pm 9.3\%$ (p -value 0.07), respectively, and the arousal index decreased with both mattress-1 and mattress-2 from 8.4 ± 11.3 arousals/hr to 6.7 ± 6.6 arousals/hr (p -value 0.35) and 6.9 ± 6.1 arousals/hr (p -value 0.29), respectively, these changes were not significant. Similarly, the increase in the percent of REM sleep seen with both mattress-1 and mattress-2 from $22 \pm 6.9\%$ to $22.7 \pm 6.7\%$ (p -value 0.69) and $25.3 \pm 7\%$ (p -value 0.21), respectively, and the decrease in the percent of stage 1 sleep with both mattress-1 and mattress-2 from $9.1 \pm 7.6\%$ to $7.3 \pm 3.6\%$ (p -value 0.41) and $5.7 \pm 3.6\%$ (p -value 0.07), respectively, were not significant.

Conclusion: In normal individuals, changing to a new mattress may affect overall sleep quality. Further studies with larger number of subjects and possibly over a more prolonged period of time are warranted.

0846

INDICATORS OF STRESS ARE ASSOCIATED WITH WORSE SLEEP QUALITY IN INDIVIDUALS EXPERIENCING RECENT MARITAL SEPARATION

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Introduction: Previous research has shown the Ruminative Response Scale (RRS), Perceived Stress Scale (PSS), and Satisfaction With Life Scale (SWLS) all to be associated with either insomnia or general poorer sleep quality. Although these measures have been examined in relation to sleep, they have not been looked at in a population experiencing marital separation. These individuals are of interest because marital separation provides an opportunity for intensified experience of stress.

Methods: Seventy-two individuals (Males = 22, M age = 45, range = 24-65) within 5 months of physical separation from their ex-partner completed measures at baseline. Self-report measures included the Satisfaction With Life Scale (SWLS), Rumination Response Scale (RRS), Perceived Stress Scale (PSS), and sleep diaries. Actigraphy provided an objective measure of sleep. Regression analyses were used to examine the relationships between SWLS, PSS, and RRS as predictors of sleep.

Results: In this newly separated sample there is an association between life satisfaction, rumination, stress, and sleep such that when reported life satisfaction is higher, less time in bed ($\beta = -.25$, $p < .05$) and higher sleep efficiency ($\beta = .25$, $p < .05$) are reported. More rumination is associated with worse objective sleep efficiency ($\beta = -.25$, $p < .05$) while higher stress is related to more reported awakenings ($\beta = .25$, $p < .05$).

Conclusion: Sleep of individuals experiencing marital separation may benefit from decreasing rumination, perception of stress, and improving life satisfaction. Future research should focus on rumination and stress perception as moderators of the relationship between life satisfaction and sleep quality in a population experiencing marital separation, effects that have been demonstrated in insomniacs and single individuals seeking new relationships.

Support (If Any): The data for this project was collected under HD069498 (RB).

0847

INDIGENOUS SIBERIAN ADULTS' SLEEP AND OBESITY RISKS IN AUTUMN

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Introduction: Over the last generation, urbanizing populations throughout the world have experienced dramatic increases in rates of obesity and related metabolic diseases. Yet, few studies have explored whether changes in sleep may be an important axis through which lifestyle changes influence energy balance and obesity risks. This study examines these questions in an urbanizing indigenous population of the Siberian arctic that experiences extreme seasonal shifts in daylight.

Methods: Data collection took place in a rural village in the Sakha Republic/Yakutia, Russia in autumn (day length 13.5-13.0 hours). Indigenous Siberian (Yakut) adults ($n = 184$, 52 men; mean age 51.5, SD 14.7 years) were interviewed to assess sleep habits (sleep quality, daytime sleepiness, sleep disruptions, snoring) and underwent anthropometric measures (height, weight, body mass index [BMI], waist circumference [WC], percentage body fat [pctfat]). Sleep variables were reduced to binary categories and compared against continuous anthropometric variables using logistic regressions, controlling for sex and age.

Results: Poor sleep quality and daytime sleepiness were both reported by 19% of the participants. Snoring was prevalent (42.9%) within this sample, with no sex differences found. Sleep disruptions were common, with 45% of participants reporting waking up two or more times per night and 32% getting out of bed two or more times per night. Mean BMI, WC and pctfat for this sample were: 25.5 kg/m^2 (SD 4.5), 92.4 cm (SD 12.5), and 39.4% (SD 9.1), respectively. No anthropometric variable was significantly associated with daytime sleepiness. Pctfat was significantly and positively related to snoring, but not to other sleep variables. Snoring and sleep disruptions (times waking and times getting out of bed) were associated with significantly higher average weight, BMI and WC.

Conclusion: Among the Yakut adults, body mass and fatness are significantly related to snoring and sleep disruptions, but not to subjective sleep quality or excessive daytime sleepiness.

0848

RATIO OF LOW TO HIGH DENSITY LIPOPROTEINS ASSOCIATED WITH INSOMNIA SYMPTOMS IN THE AMERICAN POPULATION

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Introduction: Although high lipid levels tend to be associated with short sleep duration and poor sleep quality, it is unclear whether high levels of healthy lipids may be associated with better sleep. Few population-level studies have examined HDL cholesterol and LDL:HDL ratio relative to sleep duration and quality.

Methods: Data from the 2007-2008 NHANES were used. Participants included individuals who provided blood for lipid assays and responded to sleep questions ($N = 2594$). Sleep symptoms included self-reported difficulty falling asleep, difficulty maintaining sleep, non-restorative sleep, and daytime sleepiness, coded as minimal (< 5 days/month), mild (5-14 days/month) or severe (≥ 15 days/month). Sleep duration and sleep latency were coded in whole numbers. Blood collections and assay procedures were standardized for NHANES; values were mg/dl. Population-weighted multinomial regression analyses examined rela-

tionships of high-density lipoprotein (HDL), low-density lipoprotein (LDL), and LDL:HDL ratio to sleep symptoms, adjusting for age, sex, race/ethnicity, education and smoking. Body mass index was added in a separate model. Similar analyses using linear regression evaluated sleep duration and latency.

Results: LDL levels were not associated with any sleep parameters (all $p > 0.05$). HDL was negatively associated with severe difficulty falling asleep (OR = 0.99, $p = 0.022$), non-restorative sleep (OR = 0.99, $p = 0.033$), and daytime sleepiness (OR = 0.98, $p = 0.004$), as well as continuous sleep duration ($B = 0.003$, $p = 0.030$). LDL:HDL ratio was associated with severe difficulty falling asleep (OR = 1.21, $p = 0.033$). When BMI is added to models, significant relationships were only found between LDL:HDL ratio and severe difficulty falling asleep (OR = 1.20, $p = 0.045$).

Conclusion: HDL cholesterol (and LDL:HDL ratio) may be protective in development of cardiometabolic disease. The present analysis suggests that these are also associated with healthier sleep in the population.

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0849

THE ASSOCIATION BETWEEN NAPPING AND NIGHTTIME SLEEP QUALITY USING SELF-REPORTS AND ACTIGRAPHY

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Introduction: Prior research has suggested that napping is associated with poor self-reported nighttime sleep quality (e.g., Hays et al., 1996), whereas other studies find no association (e.g., Buysse et al., 1992). However, the relationship between napping and nighttime sleep quality can be confounded by negative response bias (i.e., self-reports may be contaminated by psychological status). Here, we examined the relationship between frequency of napping and nighttime sleep quality using both self-reports and an objective measure of sleep: actigraphy.

Methods: 436 undergraduates (age = 19.88 ± 1.50 years, 50% female) took a napping survey and the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). A subsample of 97 participants wore an actigraph for up to one week after the survey. We used Pearson correlation coefficients to analyze associations between nap frequency and nighttime sleep quality using self-reports and actigraphy.

Results: Self-reports revealed that people who nap more frequently have significantly worse subjective sleep quality, $r = .20$, $p < .0001$. When analyzing subdomains of the PSQI, napping was associated with worse sleep quality ($r = .20$, $p < .0001$), shorter sleep duration ($r = .17$, $p = .0004$), worse sleep efficiency ($r = .11$, $p = .027$), and increased daytime dysfunction ($r = .19$, $p < .0001$). However, for the objective indicators of nighttime sleep quality, napping was not associated with actigraphy measures of sleep latency ($r = .12$, $p = .26$), sleep efficiency ($r = -.06$, $p = .55$), wake after sleep onset ($r = .10$, $p = .35$), and total sleep time ($r = -.13$, $p = .19$).

Conclusion: Napping and nighttime sleep quality are associated using subjective, but not objective, reports of sleep quality. Associations between napping and sleep quality may therefore be confounded by response bias. For example, individuals with high levels of depression or stress may nap more frequently and overestimate or overreport sleep disturbance.

0850

ASSOCIATIONS BETWEEN NAPPING AND SUBJECTIVE SLEEP QUALITY: THE ROLE OF DEPRESSION, STRESS, AND GENERAL HEALTH

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Introduction: Some studies report napping is associated with worse subjective nighttime sleep quality (Hays et al., 1996) while others show no relationship (Dautovich et al., 2008). Other variables may have contributed to the conflicting findings. For example, depression and stress are associated with worse nighttime sleep quality (Hall et al., 2000). Additionally, frequent napping is associated with poor health (Qureshi et al., 1997). It remains unclear whether napping and sleep quality are associated independent of health status. Here, we examined associations between self-reported napping and nighttime sleep quality, controlling for depression, stress, and general health.

Methods: 436 undergraduates (age = 19.88 ± 1.5 yrs, 50%F) took a large survey that included items on sleep quality (Buysse et al., 1989), depression (Radloff, 1977), stress (Cohen et al., 1983), and health (Ware Jr. & Sherbourne, 1992). We used stepwise linear regression to examine the influence of these factors on subjective sleep quality. Stress and general health were centered at their medians and depression was centered at the clinical cutoff score to aid in interpretability of the parameter estimates.

Results: Napping explained 3.54% of the variance in nighttime sleep quality ($\beta = .20$, $p < .0001$). However, depression, stress, and health explained an additional 26.2% of the variance in nighttime sleep quality (29.77% total). Depression was the largest predictor ($\beta = .25$, $p < .0001$), followed by health ($\beta = -.20$, $p < .0001$), stress ($\beta = .19$, $p = .0006$), and napping ($\beta = .13$, $p < .0001$).

Conclusion: Although napping and poor sleep quality are associated, depression, stress, and health explain more of the variance in nighttime sleep quality than napping. Thus, studies examining napping and sleep quality should consider other characteristics of the population, particularly depression, stress and health status.

0851

SHORT PARTIAL SLEEP DEPRIVATION EFFECT ON CORTICAL EXCITABILITY

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Introduction: Sleep deprivation might have various effects on brain function. It is a powerful activator of seizures in epilepsy. However, the mechanisms underlying these effects are largely unknown. A lot of previous studies showed that sleep deprivation had increased cortical excitability especially in epilepsy patients. Transcranial magnetic stimulation (TMS) can be used as a safe and non-invasive method for the measurement of cortical excitability. We used TMS for assessing sleep deprivation effects on cortical excitability in healthy population

Methods: We performed single and paired pulse TMS stimulation on dominant hemisphere of 16 normal healthy young people after partial sleep deprivation. We evaluated: 1) the relaxed motor threshold (RMT), 2) the threshold of the cortical silent period (CSP), 3) the duration of CSP elicited by five stimulus intensities (120%, 140% and 150% of RMT), 4) the short intracortical inhibition, and 5) the intracortical facilitation. The Stanford Sleepiness Scale was also measured.

Results: All the TMS parameters that we measured were unchanged despite of significant increased SSS after 3 days of partial sleep deprivation. The results were same even after 5 days of partial sleep deprivation. **Conclusion:** Partial sleep deprivation does not have effect on normal healthy young population significantly.

0852

SLEEPINESS VARIANCE BETWEEN ATHLETES IN THREE MAJOR SPORTS

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Introduction: The Epworth Sleepiness Scale (ESS) is a validated measure for sleepiness and has been used to assess sleepiness in a variety of populations by comparing individual sleepiness results to a general population average. The goal of this study was to collect ESS data across multiple athletic disciplines in order to determine if elite level athletes exhibited higher levels of sleepiness than normal individuals and to determine if there were sleepiness differences between sports.

Methods: ESS data from 1097 male participants from three sports (basketball, baseball, and football) were collected between 2008-2012. The data pool consisted of 61 professional basketball players, 479 professional baseball players, and 557 collegiate/professional football players. The mean ages of the athletes were: baseball (24.43 ± 3.57 years), basketball (25.69 ± 4.51 years), and football (20.02 ± 1.33 years), with an overall population mean age of 22.30 ± 3.60 years.

Results: The average athlete in this population scored 7.75 ± 3.96 consistent with the accepted normal score of 7-8. Broken down by sport, average ESS scores were as follows with significance indicated via dual comparisons: baseball players (6.27 ± 3.47 , $p < 0.05$), basketball players (7.84 ± 3.88 , $p < 0.05$), and football players (9.00 ± 3.93 , $p < 0.05$).

Conclusion: While this study did not show a statistically significant difference between the average elite athlete's score on the ESS and that of the normal population, statistically significant differences appear in the average scores between athletic disciplines. There are still many factors to consider (sample size differences between sports, collegiate versus professional sports, travel considerations, etc.) as this study indicates that there may be intrinsic differences in the sleepiness levels of these athletes. Future studies will be needed to determine the nature of these differences.

0853

STABILITY OF OBJECTIVE SLEEP DURATION OVER THE LAST 50 YEARS IN HEALTHY INDIVIDUALS

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Introduction: Some studies have suggested that average sleep duration has declined over the last few decades. Such findings, combined with epidemiologic evidence linking short sleep with health risks, and experi-

mental evidence of adverse effects of sleep deprivation, have provoked widespread alarm that chronic sleep deprivation has become a public health crisis. However, recent reviews of self-reported data have cast doubt on whether nighttime or 24-hr sleep has decreased in recent decades, and whether there has been an increased prevalence of short sleep. The aim of this study was to examine whether there has been a decline in objective sleep duration over the past 5 decades.

Methods: We searched PubMed for studies published in 1960-2013 that: (1) included adults without sleep problems; (2) reported all-night average total sleep time (TST) assessed via polysomnography or actigraphy under normal sleep conditions. The search identified > 3,500 studies, of which 62 met these inclusion criteria, generating 125 data points.

Results: Logistical regression analysis showed no significant association of sleep duration with year of study. Indeed, there was a slight trend for longer TST over time.

Conclusion: The results are consistent with recent reviews of historical patterns of subjective sleep duration. Nonetheless, assumptions about a steady decline in sleep duration persist, and could be explained by many factors. For example, increased public awareness and scientific knowledge about the dangers of inadequate sleep, coinciding with an exponential increase in sleep disorders diagnoses with the emergence of sleep medicine, have partly shaped these perceptions. It is beyond dispute that disrupted and inadequate sleep are prevalent and associated with significant risks, and that experimental sleep deprivation has many negative effects. Thus, speculation regarding a recent epidemic rests largely on the question of whether sleep duration has declined in the last few decades. This review does not support this notion.

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0854

EXPOSURE TO DIM LIGHT AT NIGHT INCREASES REM SLEEP AND AWAKENINGS

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Introduction: Recently, artificial light at night (LAN) has been a social problem. Exposure to LAN has been reported to be associated with the risk of breast cancer, heart disease, obesity and mood disorders. However, there are few studies on the effect of dim LAN on sleep structure in human. We investigate the effect of dim LAN exposure during sleep in healthy young male subjects.

Methods: Total of 30 healthy young male volunteers from 21 to 29 years old were recruited for the study, and they were divided into two groups depending on the exposed light (5 lux and 10 lux), randomly. During one week prior to study, the subjects had to wear actigraph (Actiwatch-L, Mini Mitter) to identify sleep-wake cycle, finally a total of 23 healthy subjects left for the study (11 subjects for 5 lux group and 12 subjects for 10 lux group). In order to exclude the effects of the first night effect, we performed polysomnography session with no light during sleep at first night of study. At the second night, 23 subjects underwent polysomnography session with no light. At the third night, 23 subjects underwent polysomnography session with two different dim lights depending on groups, which are 5 lux and 10 lux groups, during whole sleep. We analyzed sleep study data only in the second and third night studies.

Results: We found significant sleep structural differences between the second and the third night, but there is no difference between two different lux groups (5 lux and 10 lux). Dim LAN during sleep was significantly associated with increased wake after sleep onset (WASO; $p = 0.014$), increased stage 1 sleep (N1; $p = 0.038$), decreased stage 2 sleep (N2; $p = 0.004$), increased duration of REM sleep ($p = 0.014$) and marginally decreased REM density ($p = 0.056$).

Conclusion: From the results of the study, we found that dim LAN during sleep affects sleep structure regardless of the lux of light. Dim LAN during sleep increases the frequency of arousals, amount of shallow sleep and amount of REM sleep. This finding suggests the adverse effects of dim LAN during sleep on sleep quality, and also suggests the need to avoid exposure to LAN during sleep even dim light.

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0855

TRAIT-LIKE INTERINDIVIDUAL DIFFERENCES IN DYNAMICS OF SLEEP STAGE TRANSITIONS IN HEALTHY YOUNG ADULTS

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Introduction: Evaluating the dynamics of sleep stage transitions may yield new insights into underlying mechanisms of human sleep physiology. Most PSG-assessed sleep variables are substantially trait-like, with large differences between subjects, but whether interindividual differences in sleep stage transitions are also trait-like has not been studied. Here we report on stable and robust interindividual differences in sleep stage transitions in healthy young adults.

Methods: N = 25 subjects (29 ± 6 years, 14 females) underwent two successive baseline PSGs followed by a recovery PSG after 36 h total sleep deprivation in a strictly controlled laboratory environment (all TIB 22:00-10:00). PSG records were scored visually according to the criteria of Rechtschaffen and Kales; stages S3 and S4 were combined into slow wave sleep (SWS). Trait-like interindividual differences were assessed by calculating intraclass correlation coefficients (ICCs) across the baseline and recovery nights for the frequencies of the transitions between stages wake (W), REM, S1, S2 and SWS.

Results: The most common transitions were W-to-S1 (average frequency: 20.8), S1-to-S2 (20.8), S2-to-SWS (20.7), SWS-to-S2 (18.2), S2-to-W (14.9), REM-to-W (9.2), S2-to-REM (7.6), W-to-S2 (6.8), S2-to-S1 (6.0), S1-to-W (5.9), W-to-REM (4.2), REM-to-S2 (3.4) and S1-to-REM (3.1). ICCs for these transitions were all statistically significant ($P < 0.05$). ICCs were substantial (> 0.6) for transitions S1-to-S2 and W-to-S2; moderate (0.4-0.6) for W-to-S1, S2-to-W, REM-to-W, S2-to-REM, S1-to-W, W-to-REM, REM-to-S2 and S1-to-REM; and fair (0.2-0.4) for S2-to-SWS, SWS-to-S2 and S2-to-S1. In the recovery night after 36 h sleep deprivation, as compared to the baseline nights, the frequencies of transitions W-to-S1, S1-to-S2 and S2-to-W were significantly decreased and transitions S2-to-REM and REM-to-S2 were significantly increased ($P < 0.05$). Nonetheless, the magnitude of the trait-like interindividual differences consistently exceeded the magnitude of the group-average effect of 36 h sleep deprivation on the frequency of sleep stage transitions.

Conclusion: In this sample of healthy young adults, sleep stage transitions exhibited significantly stable and robust interindividual differences across baseline and recovery nights. This finding suggests that mechanisms underlying the dynamics of sleep stage transitions may be considerably trait-like.

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0856

EFFECT OF 3 DOSES OF ALCOHOL VS. PLACEBO ON SLEEP STAGES IN 102 HEALTHY MALES 30-69 YEARS OLD

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Introduction: There is interest in the effects of alcohol on sleep and sleep stages at commonly consumed preprandial amounts, even forensic interest for certain cases.

Methods: The post hoc analysis reported here was part of a study that primarily assessed risk factors of hypoxic events: age (30-69), weight, snoring and alcohol dose (placebo: 0.03 vs 0.31 (~2 drinks), vs. 0.65 (~4 drinks) vs. 0.81 (~5 drinks) gm/kg bodyweight of ethanol in 18 ounces of ginger ale consumed within within 1 hour, 1.5-2 hours prior to lights out of PSG), in 102 healthy males (physical exam, pulmonary functions, blood chemistry, PSG, except for obesity in 2 obese group (obese snorers (OS): 120-139%; very obese snorers (VOS): $\geq 140\%$ of ideal body weight). There were 2 non-obese groups: non-snorers & snorers. Each dose/PSG within-subject was separated by 48 hours, objectively and subjectively screened for recent alcohol use, randomly assigned, doses given double-blind, counterbalanced in a Latin-Square design, analyzed post hoc, using repeated measures ANOVA.

Results: The overall effect of alcohol on sleep in these groups produced the following significant/trends in sleep stages: REM sleep: Significant dose effect only for decreasing REM sleep ($p < 0.001$), dose linear ($p < 0.01$), contrast placebo vs: 0.65 g/kg and 0.81 g/kg doses (both at $p < 0.05$). Trend for fewer REM periods, dose effect trend ($p < 0.07$), dose linear ($p < 0.01$), contrast placebo vs: 0.65 g/kg and 0.81 g/kg doses (both at $p < 0.05$). Significant dose by group interaction ($p < 0.01$), significant dose only for OS ($p < 0.01$), with one significant contrast, placebo vs 0.81 g/kg doses ($p < 0.01$). Trend for dose effect in the VOS group ($p < 0.11$) with one significant contrast, placebo vs 0.65 g/kg doses ($p < 0.05$). TST and nonREM (stages 1-4) trends.

Conclusion: In 30-69 year old healthy males, alcohol significantly decreases REM sleep, linearly as a function of dose; some trends in TST and non-REM (stages 1-4).

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0857

THE STUDY ON LOW DOSES ALCOHOL AND THE EFFECT OF SLEEP QUALITY

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Introduction: The influence of alcohol on sleep quality has not been investigated. For example it has been known that a large amount of alcohol taken before bedtime tend to shorten sleep latency, increase nonrapid eye movement sleep and reduce rapid eye movement sleep in the first half of sleep. In contrast, the influence of a small amount of alcohol consumption on sleep quality remains unclear. This study was to compare the relative effects on performance of sleep quality and low doses alcohol consumed.

Methods: Eight healthy subjects, including four males and four females were enrolled in this study. Subjects consumed no alcohol, 0.16, 0.28,

0.32, 0.45, 0.50, 0.60, 0.64, 0.69 g per kilogram of body weight (g/kg) (58% alcohol), respectively, before 1-1.5 hours going to bed. Sleep quality and health conditions were evaluated using the Cardiopulmonary Coupling Analysis.

Results: These results indicated that ingestion of alcohol may affect sleep quality. Following an evening 0.16-0.32 (g/kg) (58% alcohol), a better quality and efficiency on females, and 0.45-0.60 (g/kg) (58% alcohol), a better quality and efficiency on males (shortened sleep latency, reduced number of wake periods, decreased stage 1 sleep) occurred primarily during the first half of the night with signs.

Conclusion: Alcohol has extensive effects on sleep. In healthy people, acute high alcohol doses disturb sleep, whereas in insomniacs, lower doses may be beneficial. The effects of alcohol appear to be bidirectional in that nocturnal sleep quantity and continuity. We found moderate drinking reduces the quantity of sleep, while heavy drinking reduces the quality of sleep. Sleep quality and sleepiness may also relate to rates of alcohol drinking and become a gateway to excessive alcohol use. To investigate these issues and identify the mechanisms underlying the relationship between alcohol and sleep remain important tasks, also the differences between alcohol's effects on men and women's physiological functions during sleep.

0858

THE RELATIONSHIP BETWEEN PERCEIVED REDUCED (IMMUNE) RESISTANCE, SLEEP AND DAYTIME FUNCTIONING

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Introduction: It has been suggested that immune functioning acts as a mediator in the relationship between sleep and health. The current survey was conducted to explore the relationship between perceived reduced (immune) resistance and sleep, with a specific focus on sleep apnea, insomnia, circadian rhythm disorders, and daytime functioning.

Methods: A survey was held among Dutch young adults (18-35 years old). In addition to demographics, questions were answered on perceived immune function (resistance) and its relationship with sleep quality and duration. SLEEP-50 subscales of sleep apnea, insomnia, circadian rhythm disorder, and daytime functioning were completed, and scores of subjects reporting reduced resistance were compared to those reporting a normal health status.

Results: N = 574 Dutch young adults (mean age 22.3 years old, 68.5% women) completed the survey. N = 209 subjects (36.4%) reported reduced resistance. They were significantly older (22.5 versus 21.9 years old, $p = 0.024$), smoked more cigarettes per day (1.8 versus 0.7 cigarettes, $p = 0.001$) and consumed more alcohol per week (10.5 versus 8.1 drinks, $p = 0.009$) when compared to subjects that reported a normal health status. According to SLEEP-50 thresholds only few of the subjects could be formally classified as having a sleep disorder (N = 13, 2.2%). Nevertheless, clear differences in sleep scores were found related to perceived immune status. Relative to those reporting a normal health status, subjects with reduced resistance reported significantly higher scores ($p = 0.0001$) on sleep apnea (2.6 versus 3.6), insomnia (5.1 versus 6.8), and circadian rhythm disorder (2.1 versus 2.7). Sleep quality was rated significantly lower in those reporting reduced resistance (6.8 versus 7.2, $p = 0.0001$), but no significant difference was found on total sleep time. Subjects with reduced resistance also reported significantly poorer daytime functioning (5.4 versus 7.6, $p = 0.0001$).

Conclusion: Perceived reduced (immune) resistance is associated with sleep disturbances and impaired daytime functioning.

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0859

UNDERSTANDING BEHAVIORAL OUTCOMES IN CHILDREN WITH SLEEP DISORDERED BREATHING WITH NOVEL INDICES FROM THE OVERNIGHT PHOTOPLETHYSMOGRAM

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Introduction: Attentional deficits and externalizing behaviors are common in children with sleep disordered breathing (SDB). Physiological disturbances such as respiratory disturbances sleep fragmentation, and hypoxemia may mediate neurobehavioral outcomes and their measurement with polysomnography (PSG) may help identify children with behavioral morbidities or those likely to respond to treatment. However, traditional PSG measures have been poorly discriminative or predictive of behavioral outcomes. We hypothesized that indices reflective of autonomic nervous system (ANS) function from the photoplethysmogram (PPG) of the pulse oximeter may associate with behavioral outcomes better than traditional SDB measures.

Methods: Participants consisted of a sample of 99 children from the Childhood Adenotonsillectomy Trial, ages 5-9 years, with mild to moderate SDB. Periods of 50% reduction of signal amplitude ≥ 5 seconds were identified from the PPG; a suppression index ratio (SIR) was calculated as the ratio of the decrease in PPG signal amplitude to the pre-suppression amplitude. Outcomes included the behavioral subscores from the Child Behavioral Checklist (CBCL externalizing problem and aggression behavioral T scores) and Connor's Parent Rating ADHD Scale T score.

Results: The mean (SD) T-scores for the CBCL externalizing, CBCL aggression and Connor's ADHD scales were 49.8 (9.5), 54.0 (5.6) and 53.0 (7.1). The SIR correlated with the externalizing score ($r = 0.26$, $p = 0.010$), aggression score ($r = 0.27$, $p = 0.007$), and ADHD index ($r = .21$, $p = 0.04$). SIR correlated with arousal index ($r = 0.21$, $p = .04$) but not with AHI or hypercapnia. None of the traditional PSG indices correlated with behavioral outcomes. Relationships between SIR and behavior persisted after adjusting for age, gender, race, maternal education, AHI and arousal index.

Conclusion: Information from the photoplethysmogram recorded during overnight oximetry may help identify which children with SDB are at increased risk for behavioral problems. These studies support further evaluation of ANS function and neuromodulatory influences on childhood behavior.

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0860

SERUM FERRITIN THRESHOLD FOR IRON SUPPLEMENTATION IN A REFERRED PEDIATRIC POPULATION WITH RESTLESS SLEEP

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Introduction: Previous investigations suggest an association between restless legs syndrome (RLS) or periodic limb movements of sleep (PLMS) and iron status. Increased restlessness symptoms in sleep are associated with a serum ferritin < 50 mcg/L in adults. This threshold is used to guide iron supplementation in children with restless sleep despite conflicting results in small pediatric studies. Our objective is to examine if the serum ferritin threshold of 50 mcg/L is an accurate determinant of treatment initiation in a pediatric population suffering from restless in sleep.

Methods: Retrospective review of 537 children (0-18 yrs), referred for evaluation in the University of Michigan Pediatric Sleep Clinic. Data collected included patient demographics, hematology, and polysomnographic (PSG) measure of limb movements per hour (PLMI). Serum ferritin and PLMI were examined by logistic regression, controlling for age, gender, and time between hematology and PSG. Serum ferritin was also examined using categorical cutoffs.

Results: Mean age is 8.85 ± 4.37 years, 61.6% of patients are male, and 85% are white. Serum ferritin level is associated with a probability of having PLMI ≥ 5 ($p < 0.0017$). When PLMI < 5 , median ferritin is 30 mcg/L. When PLMI ≥ 5 , median ferritin is 23.6 mcg/L. Being male, lower ferritin, younger age, and shorter time between hematology and PSG increase the odds of PLMI ≥ 5 ($p = 0.005$, 0.042, 0.021, and 0.005 respectively). When comparing ferritin ≥ 20 mcg/L and < 20 mcg/L, increased odds of PLMI ≥ 5 are associated with being male, lower ferritin, younger age, and shorter time between hematology and PSG ($p = 0.004$, 0.012, 0.015, and 0.006). Other ferritin thresholds do not demonstrate this relationship.

Conclusion: This study suggests that a ferritin threshold of 20 mcg/L is a better predictor of having PLMI ≥ 5 , consistent with PLM disorder, in the pediatric population. Using the adult threshold in children may result in inappropriate iron supplementation.

Support (If Any): Charles Woodson Fund for Clinical Research.

0861

THE EFFECT OF SLEEP DISORDERED BREATHING ON CEREBROVASCULAR HEALTH IN PEDIATRIC PATIENTS WITH SICKLE CELL DISEASE

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Introduction: Sickle cell disease (SCD) is a genetic disorder that causes hemolytic anemia and occlusive vasculopathy. Previous work has demonstrated that cerebrovascular reactivity (CVR), a measure for vascular health, was globally reduced compared to healthy controls in the pediatric SCD population. CVR reflects the capacity of blood vessels to regulate blood flow in the presence of a vasoactive stimulus. In addition, a high percentage of individuals with SCD suffer from obstructive sleep apnea (OSA). This can lead to repeated episodes of nocturnal hypoxia, hypercapnia and sleep disruption. It is currently unknown if the presence of OSA in the pediatric SCD population will further impair cerebrovascular health. Therefore, by comparing the MRI derived CVR values in the OSA versus the non-OSA cases in the pediatric SCD

population, we will gain valuable insight into their combined effect on cerebrovascular health.

Methods: 17 SCD patients, 7 with OSA (8-18 years) and 10 without OSA were imaged on a 3T MRI scanner. CVR data was acquired using a blood-oxygen level dependent (BOLD) sequence during a computer-controlled administration of CO₂ delivered in programmed cycles of low and increased levels through a rebreathing mask. High resolution CVR maps were computed using FSL v4.1 and the CVR maps were then converted into surface maps through CIVET. The surface maps were then coregistered into the MNI pediatric MRI Atlas, which was manually segmented into the corresponding Brodmann regions. MATLAB based program SurfStat was used to perform Student's t-tests on CVR between the groups in order to identify significantly different Brodmann regions.

Results: From the CVR group comparison analysis, we observed that global grey matter CVR levels as well as CVR levels in several Brodmann areas showed a significant reduction in the OSA SCD group ($p < 0.05$).

Conclusion: In this study, we have demonstrated significantly reduced CVR values in SCD patients with OSA compared to SCD patients without OSA in different parts of the brain. Reduced CVR may expose individuals who suffer from SCD and OSA to a higher risk for serious vasculopathies such as stroke and early recognition and intervention of sleep disturbances in children with SCD may reduce morbidity in these children.

0862

LONG-TERM EFFECTS OF CAFFEINE THERAPY FOR APNEA OF PREMATURITY ON SLEEP

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Introduction: Apnea of prematurity is a common condition that is usually treated with caffeine. Caffeine is an adenosine receptor blocker that has powerful influences on the central nervous system. However, little is known about the long-term effects of caffeine on sleep in the developing brain. In particular, it is not known whether neonatal caffeine administration has permanent adverse effects on sleep architecture and ventilatory control, resulting in an increased prevalence of sleep disorders such as insomnia and obstructive sleep apnea. We hypothesized that neonatal caffeine use resulted in long-term abnormalities in sleep architecture and breathing during sleep.

Methods: 201 ex-premature (500-1,250 gm) children aged 5-12 years who participated as neonates in a double-blind, randomized clinical trial (Caffeine for Apnea of Prematurity [CAP]) of caffeine versus placebo underwent sleep questionnaires, actigraphy and full ambulatory polysomnography.

Results: There were no significant differences in sleep quality or quantity based on actigraphy and questionnaires between the caffeine group vs placebo. Total recording time and total sleep time on polysomnography were longer in the caffeine group, but there was no difference in sleep efficiency between groups. Obstructive sleep apnea (apnea hypopnea index $> 2/hr$) was common (8.2% of caffeine group vs 11.0% of placebo) compared to normative literature. Further, 24% of the caffeine and 29% of the placebo group had either obstructive sleep apnea on polysomnography and/or a history of adenoidectomy/tonsillectomy. However, neither the apnea hypopnea index nor the proportion of children with

obstructive sleep apnea differed between groups. The proportion of subjects with elevated periodic limb movements was high (17.5% in caffeine vs 11% in placebo) but did not differ significantly between groups.

Conclusion: Therapeutic neonatal caffeine administration has no long-term effects on sleep pathology during childhood. However, preterm infants are at risk for obstructive sleep apnea and periodic limb movements in later childhood.

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0863

DOES OZONE EXPOSURE INCREASE APNEA AND BRADYCARDIA DURING SLEEP IN INFANTS?

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Introduction: Early-life exposures to ambient air pollutants including ozone (O₃) result in increased infant mortality and poor respiratory health in children. Disturbed sleep was found in rats exposed to O₃, but human data are scant. Infants sleep 16 to 18 hours a day and depend on healthy sleep for appropriate growth and development. Studying the association between air pollution and sleep-associated cardiopulmonary events in infants may help elucidate a novel pathway linking early-life exposure to adverse health effects in childhood.

Methods: We examined the association between O₃ and cardiopulmonary events using preliminary data from a panel of 205 infants residing in Southern California and recruited in 1994-8 for the Collaborative Home Infant Monitoring Evaluation Study with home-based monitoring of cardiorespiratory events (apnea; bradycardia) aggregated over 24 hours. Historical daily O₃ exposure was assigned to each residential address, with a geostatistical method using ambient air data from the regional monitoring network. Negative binomial models were employed to examine the associations.

Results: Preliminary results suggest adverse short-term O₃ effects on cardiorespiratory events. One-ppb elevation in daily and 3-day moving average O₃ exposures was associated with increased events [apnea lasting ≥ 20 sec and heart rate < 80 , 60 or 50 beats per minute based on duration of event and age of infant] frequencies by 1.3% ($p < 0.05$) and 2.0% ($p < 0.05$), after accounting for seasonality, weekday, and individual random effect. Adverse O₃ effects were also present for both exposures with 1-day lags.

Conclusion: Increased O₃ exposure may increase cardiorespiratory events in infants during sleep. We speculate that the observed O₃-apnea/bradycardia association implies a possible mechanistic pathway for subsequent adverse health consequences of early life and merits further investigation.

Support (If Any): Pilot Project Grant from the NIEHS-funded USC/UCLA Southern Environmental Health Sciences Center and a Seed Grant from the American Medical Association.

0864

ALTERED NEURONAL RESPONSE TO LOWER BODY NEGATIVE PRESSURE IN CHILDREN WITH OSA MEASURED BY MAGNETOENCEPHALOGRAPHY

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Introduction: The central autonomic network plays a critical role for neurogenic regulation of arterial blood pressure. Magnetoencephalography is a functional neuroimaging technique for mapping brain activity that provides measures of brain responses to perceptual and cognitive stimuli. We have previously demonstrated that obstructive sleep apnea (OSA) in children is associated with reduced baroreflex sensitivity which does not normalize after treatment. We hypothesized that dysfunction of the central autonomic network in children with OSA is associated with consistently decreased baroreflex sensitivity.

Methods: Magnetoencephalography acquisitions in a CTF 275-channel magnetometer at 600 Hz were conducted in 3 untreated OSA, 3 treated OSA and 3 control subjects during exposure lower body negative pressure (LBNP). Six trials of exposure to LBNP were conducted at -5 and -30 mmHg for 30 s alternating with 100 s exposure to atmospheric pressure. Source strengths were compared, per trial, between 5 s windows just before and just after start of LBNP. Mean contrast in this temporal response was calculated per subject. Differences in group means were expressed as effect sizes after scaling by pooled subject standard deviation

Results: In the comparison between untreated OSA and controls the response to LBNP (-30 mmHg vs. -5 mmHg) was greater (effect size > 1) for untreated OSA compared to controls, bilaterally covering inferior and superior parietal, angular gyri, precuneus, pre- and post-central gyri, and inferior frontal regions. The response in the untreated group tended to exceed controls in the left insula. Treated OSA also tended to have greater response than controls in the same cortical regions but to a lesser degree (effect size controls in the right insula).

Conclusion: Differences in baroreceptor sensitivity between children with OSA and controls could be explained by functional abnormality of the central autonomic network.

0865

THE RELATIVE EFFECT OF SLEEP DISORDERED BREATHING AND OBESITY ON NEUROCOGNITIVE FUNCTIONING IN ADOLESCENTS: GENDER EFFECTS

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Introduction: Sleep disordered breathing (SDB) has been associated with impaired neurocognitive functioning in previous studies. No study to date has examined the relative association of SDB and obesity with neurocognition in a general population sample of adolescents.

Methods: The Penn State Child Cohort is a random sample of 700 children aged 5-12 years (8.6 ± 1.7 y) at baseline of whom 421 (53.9% male) were followed-up 8 years later during adolescence (17.0 ± 2.3 y). All subjects underwent a 9-h polysomnography, comprehensive neurocognitive testing, anthropometric measures, and Dual-energy X-ray Absorptiometry (DXA) scans.

Results: SDB was associated with impaired general ability (BetaSDB = -.091, $p < .07$) and achievement (BetaSDB = -.114, $p < .05$); however, we found a significant interaction between female gender and SDB on general ability (BetaSDBxGender = -.119, $p <$

.05) and that obesity mediated the association of SDB with achievement (BetaWaist = -.196, $p .05$). In fact, obesity was associated with impaired vigilance (BetaVisceral = -.132, $p < .05$), processing speed (BetaWaist = -.146, $p < .01$), working memory (BetaBMI = -.115, $p < .05$), and response interference (BetaVisceral = .131, $p < .05$). Finally, we found significant interactions between male gender and obesity on vigilance (BetaWaistxGender = .132, $p < .05$) and processing speed (BetaWaistxGender = .142, $p < .05$).

Conclusion: Obesity is more strongly associated with impaired executive functions and achievement than SDB per se. Interestingly, SDB is associated with impaired general ability in female adolescents, while obesity is associated with impaired vigilance and processing speed in male adolescents. These data suggest gender differences in the neurocognitive vulnerability to the effects of SDB and obesity that may further our understanding of different clinical presentations of SDB in men and women.

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0866

DOES MECHANICALLY ASSISTED VENTILATION INFLUENCE SLEEP ORGANIZATION AND STRUCTURE IN PRETERM NEONATES?

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Introduction: Interaction between sleep and respiratory function is well-known. However, lung function of preterm neonates is characterized by immaturity and imperfect adaptations to environmental disturbances. That is why it is often necessary to supplement with mechanically assisted ventilation (MAV). The aim of this study was to clarify the relationship between MAV and sleep in preterm neonates.

Methods: 12-hour polysomnographies were performed at night 6 (N6) and night 9 (N9) of life in a population of 52 preterm neonates nursed in closed incubators (Gestational age: 29.6 ± 1.3 wk; birthweight: 1237 ± 322 g). A ventilated-group (V, $n = 21$ at N6 and $n = 12$ at N9) and a not-ventilated-group (NV, $n = 31$ at N6 and $n = 40$ at N9) were distinguished. Sleep structure was characterized by total and average durations, the percentages and frequencies of active (AS), quiet (QS) and indeterminate (IS) sleep episodes and wakefulness after sleep onset (WASO). Sleep stability was assessed from sleep stage change frequencies.

Results: As regards to sleep structure, differences were highlighted only at N6 in NV compared to V: average duration and percentage of WASO episodes were higher (78 ± 46 min vs. 36 ± 36 min and 11 ± 6 vs. 6 ± 5 %; respectively). Mean duration and percentage of IS episodes were shorter (9 ± 2 vs. 11 ± 3 min and 26 ± 6 vs. 30 ± 5 %; respectively). Sleep efficiency was lower (89 ± 6 vs. 94 ± 5 %; respectively). The frequency of WASO episodes was higher (0.4 ± 0.2 vs. 0.3 ± 0.2 h⁻¹).

Conclusion: At N6, MAV influences WASO organization and structure in favor of IS and a better sleep efficiency. This observation is not repeated at N9. It can be assumed that the respiratory control is improved by the pulmonary and nervous maturation in NV neonates over 72 h.

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0867

PREDICTORS OF TREATMENT SUCCESS IN BEHAVIORAL SLEEP INTERVENTION AMONG PRESCHOOL CHILDREN

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Introduction: While behavioral sleep problems are known to be common in preschool children, less is known about which children are most likely to benefit from intervention or about which intervention features are most likely to be helpful.

Methods: The Sleep Health in Preschoolers (SHIP) intervention was delivered to 41 families of children 2.5-5 years with behavioral sleep problems (CSHQ ≥ 42 or < 10 hours of sleep by parent report). SHIP is a tailored, family-centered intervention that provides parents with feedback, iterative goal setting, anticipatory problem-solving, and tangible tools to improve child sleep. Both baseline and three-month follow-up assessments included parent surveys, 7-day sleep diaries, and actigraphy.

Results: On average, child sleep duration increased by 36 minutes per night (95%CI 22-51), and onset latency decreased by 10 minutes (95%CI 3-17). Significant improvements were seen in all CSWS and CSHS domains ($p < 0.001$), the Epworth Sleepiness Scale ($p < 0.001$), and CBCL internalizing ($p = 0.02$) and aggression scores ($p < 0.001$). Child baseline characteristics predicting increased treatment effects included shorter sleep duration ($p = 0.02$) and bedtime media use ($p = 0.02$). No differences were observed by age, gender, adoption, or comorbid conditions, nor were CSHQ, CSWS, CSHS, or Epworth scores significant predictors of treatment effects. Interestingly, greater effects were also observed in children whose parents did not believe at baseline that improved sleep would help their child's health or behavior; this appears partially mediated by increased parental outcomes expectations around sleep due to the intervention ($p = 0.04$). Dose of the intervention (number of contacts) was also positively associated with treatment effects ($p = 0.04$). Other intervention components that appeared to contribute most to effects included the tailored bedtime routine and anticipatory problem-solving around bedtime consistency ($p < 0.001$).

Conclusion: Overall, SHIP appears to be effective in improving child sleep and daytime functioning, although only the ongoing randomized trial can show whether these effects are causal. The lessons learned from this study will be used to strengthen the RCT. Although targeting interventions towards those most likely to respond might improve efficiency, parent report surveys may not be the best predictors of potential benefit. Outreach through primary care and community settings may be necessary to reach families who do not initially see improved sleep as important, given the potential for positive change in this population.

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0868

IMPACT OF SLEEP PRACTICES IN CHILDCARE SETTINGS ON CHILD WELL-BEING

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Introduction: Perturbation of normal sleep patterns in childhood has been independently associated with risk for obesity and accidents, poor neurocognitive functioning and behavioral problems. Childcare environments have the potential to affect children's developing sleep patterns for better and worse yet little is known about the impact of sleep

practices in childcare. This paper examines the impact of childcare practices on child wellbeing.

Methods: We addressed three research questions: 1. What are the range of sleep practices in Australian childcare? 2. How do these sleep practices relate to current knowledge regarding healthy sleep promotion? 3. How do childcare practices relate to child wellbeing and physiological stress? Standard observations of 2300 children, aged 3-6 years, attending 130 childcare centers across sleep and non-sleep sessions were conducted. The range of policies and practices relating to type of scheduling, duration of scheduling and flexibility in provision for sleepers and non-sleepers were recorded and descriptive statistics generated. Observed sleep scheduling behaviors were coded against published positive sleep hygiene behaviors. Cluster analyses were applied to identify patterns of sleep practices. Finally the association of measures of emotional climate, child behavior and patterns of salivary cortisol and variation in sleep practices were assessed.

Results: 90% of child care rooms scheduled a standard sleep time with a duration of 0-3 hours. The majority (70%) of children did not sleep during this time. Of centers scheduling sleep 50% did not permit alternate activity for non-sleeping children for a period exceeding 1 hour. Three clusters of sleep practices that variously align with good sleep hygiene recommendations were identified. Alongside, practices were systematically related to emotional climate, child distress.

Conclusion: Many childcare centers do not have optimal sleep practices. There is a need for evidenced based sleep guidelines to optimize healthy sleep development in childcare.

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0869

SLEEP PROBLEMS AND HOSPITALIZATION FOR SELF-HARM: A 15-YEAR FOLLOW-UP OF 9,000 NORWEGIAN ADOLESCENTS: THE YOUNG-HUNT STUDYJunker A¹, Bjørngaard JH^{2,3}, Gunnell DJ⁴, Bjerkeset O^{5,1}¹Department of Neuroscience, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway,²Department of Public Health and General Practice, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway, ³Forensic Department and Research Centre Brøset, St. Olavs University Hospital, Trondheim, Norway, ⁴School of Social and Community Medicine, Bristol University, Bristol, United Kingdom, ⁵Faculty of Health Sciences, Nord-Trøndelag University College (HiNT), Levanger, Norway

Introduction: Self-harm (SH) is among the most frequent reasons for hospitalisation in adolescents, and the strongest single risk factor for suicide. Sleep problems have been identified as a risk factor for SH, yet evidence from prospective population-based studies is lacking. Further, SH was often self-reported in previous studies. We followed almost 9,000 adolescents for 15 years, and examined the prospective association between sleep problems and risk of hospitalisation due to SH.

Methods: 8,983 Norwegian 13-19 year old adolescents (88% of all invited) participated in the Young-HUNT 1 study in 1995-97. We defined problems initiating sleep and/or early morning waking as exposure, and included symptoms of combined anxiety and depression, BMI, somatic illnesses or psychosomatic symptoms, smoking and alcohol use as covariates in our analyses. Using local hospital records, we identified the index episode of hospitalisation due to SH in the cohort.

Results: 98 patients (27% males) were hospitalised following SH during follow-up, 38 (39%) of them more than once. Sleep problems were

twice as common among participants hospitalised for SH (HR 2.11, 95% CI 1.29-3.46, sex and age adjusted), yet co-existent symptoms of combined anxiety and depression explained most of the sleep problem effect on SH (HR 1.19, 95% CI 0.66-2.16, adjusted for all covariates). The HR of combined sleep problems differed significantly in those with and without anxiety/ depression at baseline; among those without caseness symptoms of anxiety/depression it was 5.58 (95%CI 2.02-15.40), while in those with caseness symptoms of anxiety/depression it was 0.82 (95%CI 0.19-3.44).

Conclusion: Sleep problems are common among Norwegian adolescents, and co-existent symptoms of anxiety and depression significantly increase risk for later hospitalisation for SH. Prevention of sleep problems, anxiety and depression should be targeted when seeking to reduce and prevent SH.

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0870

CHARACTERIZING SLEEP OF CRITICALLY ILL CHILDREN IN THE PEDIATRIC INTENSIVE CARE UNIT WITH THE FAST FOURIER TRANSFORM

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Introduction: Critically ill children in the Pediatric Intensive Care Unit (PICU) are exposed to a multitude of factors that can fragment sleep, during a time when, paradoxically, the restorative benefits of sleep are the most important for neurocognitive development. Increased delta power in the EEG during sleep in childhood has been associated with high levels of synaptic density and activity, a key component of neurologic maturation. Traditional methods of visual inspection of the EEG to characterize sleep architecture provide no insight into time-dependent effects of ICU interventions during the sleep period. The objective of this study is to characterize the sleep experience of critically ill, mechanically ventilated children with continuous recordings of the EEG.

Methods: In this pilot study, children admitted to the PICU requiring mechanical ventilation for primary respiratory failure had continuous EEG recordings for a minimum of 24 hours. The EEG was analyzed using power spectral analysis with the discrete Fast Fourier Transform (FFT), and the spectral distribution was categorized into frequency bands: δ (0.8 to 4.0 Hz), θ (4.1 to 8.0 Hz), α (8.1 to 13.0 Hz), and β (13.1 to 20.0 Hz). ICU subjects were age and gender matched to healthy controls from the community.

Results: Seven critically ill children had EEG recordings for 24 hours or more during mechanical ventilation. When compared to age and gender matched controls, children in the PICU demonstrated no evidence of homeostatic regulation of delta sleep across both the nocturnal and 24 hour periods.

Conclusion: The results of this study highlight the need for interventional studies to optimize sleep of critically ill children undergoing active neurocognitive development, challenging a PICU paradigm and

culture that assumes children are experiencing sufficient sleep during critical illness.

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0871

SLEEP DISTURBANCES IN NAÏVE CHILDREN WITH ADHD COMPARED TO NORMAL CHILDREN IN SPANISH POPULATION

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Introduction: The relationships between sleep and attention-deficit/hyperactivity disorder (ADHD) are complex and probably multifactorial, with significant impact on a child's functioning. ADHD symptomatology, and comorbidities, may disrupt sleep by increasing the probability of bedtime resistance, insufficient sleep disorder or poor sleep quality.

Methods: Patients (6-16 y.o.) must fulfill ADHD criteria (ADHD-RS IV, K-SADS) and must have never been on stimulant medication prior diagnosis (naïve ADHD). Controls matched for age, gender, ethnicity, and socio-economic status, were selected from public and private schools in the Barcelona area. Sleep, in both groups, was assessed using one-week sleep log with actigraphy recording. The Pediatric Sleep Questionnaire (PSQ), Bruni sleep questionnaire (BSQ), and Owens questionnaire (ORLSQ), to rule out restless legs syndrome (RLS), were utilized. Blood work including iron and ferritin levels was performed.

Results: Results of the first year (out of a 3-year grant). From a total of 80 subjects (40 ADHD and 40 controls), mean age 9.9 y.o (65% boys) in both groups. Among the ADHD group, 50% presented combined ADHD subtype, 40% inattentive and 10% hyperactive. Sleep log and actigraphy showed discrepancies on parent vs. children perception on total sleep time in both groups. BSQ evidenced that up to a 62.5% of patients had problems with sleep. Compared to controls, patients showed difficulties initiating and maintaining sleep ($p = 0.018$) and disturbances on sleep-wake transition ($p = 0.030$). Day-time somnolence was referred by a 30% of the ADHD group. Suspected sleep disordered breathing (SDB) was reported in a 20% of patients ($p < 0.05$). Five percent of patients presented RLS symptoms using the ORLSQ. Levels of ferritin and iron were lower in the ADHD group but not significant ($p > 0.05$).

Conclusion: Our findings support the notion that naïve patients with ADHD compared to controls have problems with sleep including: difficulties initiating and maintaining sleep, increased prevalence of parasomnias, day-time somnolence and suspected SDB, as well as symptoms of RLS independent of the levels of iron and ferritin.

Support (If Any): ISCIII (PI11/02009).

0872

EFFECTS OF OBJECTIVE SLEEP ON MOOD, TESTING A COGNITIVE VULNERABILITY MODEL OVER RESTRICTED AND EXTENDED SLEEP OPPORTUNITIES IN ADOLESCENTS

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Introduction: It is well established that for adolescents, school days are associated with sleep restriction, while insufficient sleep has been linked

to mood disturbances. In this longitudinal study over school terms with restricted, and vacations with extended sleep opportunities, a cognitive model was proposed and tested to assess whether sleep-specific (i.e., dysfunctional beliefs and attitudes about sleep) and global (i.e., dysfunctional attitudes) cognitive vulnerabilities played roles in the relationships amongst objective sleep, subjective sleep, and mood.

Methods: One-hundred and forty-six adolescents (47.3% male) aged 16.2 ± 1.0 years ($M \pm SD$) from the general community wore an actigraph continuously for four weeks: the last week of a school term (Time-E), the following two-week vacation (Time-V), and the first week of the next term (Time-S). Sociodemographic information and cognitive vulnerabilities were assessed at Time-E. Subjective sleep, symptoms of depression, anxiety, and life stress were measured at Time-E, Time-V, Time-S, and the middle of the subsequent school term. Structural equation modelling was used to examine changes of variables over time, as well as the moderating roles of cognitive vulnerabilities.

Results: Compared to vacations, school terms were associated with higher symptoms of depression, anxiety, and life stress. Poorer sleep quality, particularly poorer subjective perception of sleep quality, was significantly associated with higher symptoms of depression and anxiety. Sleep-specific cognitive vulnerability moderated the relationship between objective and subjective sleep onset latency during extended but not restricted sleep opportunity. After controlling for life stress, higher global cognitive vulnerability was associated with a stronger relationship between subjective sleep and symptoms of anxiety (but not depression) during the school term, as well as with a stronger relationship between subjective sleep and symptoms of depression (but not anxiety) during the vacation period.

Conclusion: Cognitive vulnerabilities played important roles in the relationship between sleep and mood. Adolescents with higher cognitive vulnerability might be more emotionally vulnerable towards school-related sleep restriction. These findings provide a clearer understanding of the relationship between sleep and mood, and have practical implications for interventions designed to improve adolescents' wellbeing.

0873

EXPERIMENTALLY MANIPULATED SLEEP DURATION IN ADOLESCENTS WITH ASTHMA: FEASIBILITY AND PRELIMINARY FINDINGS

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Introduction: Asthma is the most common pediatric chronic illness, impacting approximately 10% of adolescents. While sleep can be disrupted by nocturnal asthma symptoms, and disrupted or insufficient sleep may lead to an increase in daytime asthma symptoms, few studies have examined how sleep duration impacts asthma. This study used an experimentally manipulated sleep duration protocol to examine lung function, asthma symptoms, and markers of inflammation in adolescents with asthma.

Methods: Fourteen adolescents (50% male, 64% Caucasian, mean age = 14.1 years, range 12-17) completed a 3-week randomized, crossover sleep manipulation protocol. Following a week of self-selected sleep duration, adolescents were randomized to 5 nights of insufficient sleep (6.5 hrs in bed) and healthy sleep (10 hrs in bed). Wake time remained consistent across all three study weeks (including weekends). Participants completed a daily diary of sleep patterns and asthma symptoms and daily peak expiratory flow rates (PEFR). At the end of each week spirometry, exhaled nitric oxide, and serum cytokine testing were performed.

Results: All 14 adolescents were adherent with the protocol, with significant differences between study weeks found for bedtime ($p < .0001$), time in bed ($p < .0001$) and total sleep time ($p < .002$). Wake times did not significantly differ across the study weeks. Participants fell asleep earlier (mean 1.3 hours) during the healthy sleep week than their baseline bedtime. Differences between short and long weeks were found for the overnight change in PEFR [FEV1 ($p = .06$) and PEF ($p = .007$)]. During the short week, participants averaged a 7-8% decrease in PEFR from evening to morning. During the long week participants averaged only a 0-1% increase in PEFR from evening to morning. Adolescents reported asthma symptoms interfering with activities in the past 24 hours more during the short sleep week than the long sleep week ($p = .02$). No significant differences between study weeks were found for weekly spirometry, exhaled nitric oxide, or serum cytokines.

Conclusion: This pilot study demonstrates the feasibility of a crossover sleep manipulation protocol in adolescents with asthma. An overnight decrease in PEFR is a marker of nocturnal asthma and has been associated with the severity of daytime airflow limitation. The results of this study suggest that sleep duration may play a role in asthma severity in adolescents. Additional studies are now warranted with larger samples to further understand the relationships between sleep duration and asthma.

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0874

SLEEP INSTABILITY AND PERCEIVED HEALTH IN PARENTAL CAREGIVERS OF VENTILATOR-ASSISTED CHILDREN

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Introduction: Variability in sleep timing, duration, and/or fragmentation, as seen in shift-workers and insomnia sufferers, impacts behavior, affect, physiology, and disease risk. Parents of chronically ill children also may develop inconsistent sleep patterns due to the nocturnal supervision and caregiving tasks required of them. Whether variability in sleep for such parents is related to negative health outcomes has yet to be explored. This study compared inter-night sleep variability in parents of ventilator-assisted children (VENT) and healthy children (HEALTHY), and explored the relationship between sleep instability and perceived health.

Methods: Participants were 112 parents (79 mothers and 33 fathers, mean age = 42.5 yrs, SD = 7.0) from 42 VENT ($n = 56$) and 38 HEALTHY families ($n = 56$). All wore an actigraph and completed a sleep diary to identify bedtimes and rising times during a mean of 12.81 nights (SD = 1.87). Sleep variables analyzed included reported bedtimes and rising times, total sleep time (TST), wake after sleep onset (WASO), and sleep efficiency (SE). Between-family differences on averaged sleep measures and on their night-to-night instability, calculated by mean square successive differences, were assessed via multilevel models. The relationship between perceived health, as measured by the 8 scales of SF-36 questionnaire, and both averaged sleep measures and their indices of inter-night instability was tested using a model of dyadic data analysis.

Results: VENT parents showed statistically significant later bedtimes, shorter TST, longer WASO, and lower SE across nights than HEALTHY parents did (all P s $< .05$). They also exhibited greater instability in their reported rising times, WASO, and SE across days (all P s $< .05$). Adjusting for family type and gender, greater instability of rising times, WASO and SE across nights were related to poorer physical health outcomes (Physical functioning, Bodily pain and General health (all P s $\leq .05$) and

poorer mental health (Role emotional, $p = .04$). By contrast, averaged sleep values were not related to scores on these scales.

Conclusion: Averaged sleep values provide an incomplete picture of the sleep patterns of parental caregivers of children with chronic illnesses. Our findings show that sleep instability, resulting in a disruption of the normal circadian rhythm, contributes significantly to poorer perceptions of health status. Studies on intervention strategies for improving these aspects of caregiver sleep are warranted.

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0875

THE MEDIATING ROLE OF PRE-SLEEP AROUSAL IN THE RELATIONSHIP BETWEEN LIFE STRESS AND OBJECTIVE/SUBJECTIVE SLEEP ONSET LATENCY IN RESTRICTED AND EXTENDED SLEEP OPPORTUNITIES IN ADOLESCENTS

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Introduction: It is well established that for adolescents, school days are associated with restricted sleep opportunity and non-school days with extended sleep opportunity. In adults, cognitive pre-sleep arousal (e.g., bedtime thoughts and worries) has been shown to mediate the relationship between life stress and symptoms of insomnia. This study examined the mediating roles of cognitive and somatic pre-sleep arousals (PSAcog and PSAsom) in the relationship between life stress and objective/subjective sleep onset latency (SOL) among adolescent during restricted and extended sleep opportunities.

Methods: One-hundred and forty-six adolescents (47.3% male) aged 16.2 ± 1.0 years ($M \pm SD$) from the general community wore an actigraph continuously for four weeks: the last week of a school term (Time-E), the following two-week vacation (Time-V), and the first week of the next term (Time-S). At all three time points, life stress was measured by the Inventory of High-School Students' Recent Life Experiences, PSAcog and PSAsom were measured by the Pre-Sleep Arousal Scale, and subjective SOL was extracted from the Pittsburgh Sleep Quality Index. Multiple group path analysis was used to examine the mediating roles of PSAcog and PSAsom in the relationship between life stress and objective/subjective SOL.

Results: Time-E and Time-S were associated with restricted sleep opportunity and Time-V with extended sleep opportunity. Higher PSAcog was associated with significantly longer subjective SOL at all time points, as well as significantly longer objective SOL at Time-V (but not Time-E or Time-S). PSAcog significantly mediated the relationship between life stress and subjective SOL at all time points, as well as the relationship between life stress and objective SOL at Time-V (but not Time-E or Time-S). PSAsom did not share a significant relationship with either life stress or objective/subjective SOL.

Conclusion: In adolescents, cognitive but not somatic pre-sleep arousal was related to sleep onset problems. Cognitive pre-sleep arousal might play an aetiological role in stress-related sleep onset difficulties by mediating the effects of life stress on SOL. Therapeutic interventions that aim to reduce excessive bedtime thoughts and worries might reduce and protect against stress-related sleep onset problems in adolescents.

0876

DELAYING HIGH SCHOOL START TIMES: ATTITUDES, BARRIERS, AND SOLUTIONS

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Introduction: The misalignment between adolescents' biologically delayed circadian phase preferences and early high school start times contributes to decreased total sleep times, with less than 31% of high school students obtaining 8 hours/night nationally. The national movement to delay high school start times (SST) has gained momentum over the past two decades, although the debate is often contentious with challenges such as budgets, transportation, athletics, and student employment. We are reporting on a survey administered to principals and top administrators in one of the largest school districts in the country.

Methods: The online survey was administered to all principals and top administrators ($N = 260$). Part One (14 questions) measured individual administrators' attitudes, proposed solutions and perceived barriers to SST changes. Part Two (17 questions) assessed specific school resources that will not be reported here.

Results: 227 principals and top administrators (85% response rate) responded. The top 5 ranked concerns (from greatest to least) included: (1) traffic patterns, (2) changes in teachers' work schedules, (3) changes in staff commutes, (4) commuting distances, and (5) athletic game schedules. The highest rated solutions included: "Flipping" start times so that elementary schools start earlier than middle/high schools (59%), elimination of partial planning days for teachers (66%), greater focus on safe routes to school (63%), and decreasing summer break and increasing winter break (59%).

Conclusion: Although nationally over 70 school districts have delayed high school start times to align with adolescents' circadian rhythms, baseline data on barriers to changing SST is limited. As the incongruence between adolescents' late sleep/wake drives and early high school start times becomes a widely publicized public health issue, more high schools across the country will delay their SST. The results from this survey, which measures the most important community considerations associated with SST changes, may help inform future change implementation nationally.

0877

KNOWLEDGE, ATTITUDES, AND RISK FOR SUDDEN UNEXPECTED INFANT DEATH IN CHILDREN OF TEENAGE MOTHERS

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Introduction: Despite longstanding guidelines from the American Academy of Pediatrics (AAP), there are ongoing gaps in infant safe sleep practices, and the rate of sudden unexpected infant death (SUID) is increasing. This project explores knowledge, attitudes, and practices among teenage mothers, a high risk demographic for SUID, to identify effective public education strategies for infant safe sleep practice.

Methods: From 11/2012-4/2013, we conducted seven focus group discussions with teenage mothers at high school daycare centers throughout Colorado to explore attitudes and knowledge about infant sleep position and environment, as well as current practices. Additionally, we solicited opinions on effective methods to deliver safe sleep recommendations to other

young parents. Qualitative analyses of transcripts using ATLAS.ti were performed by two study team members to ensure inter-coder reliability.

Results: Of 43 school-aged female participants, most were aware of the AAP recommendations for infant safe sleep and practiced supine sleep, but used blankets or soft bedding anyway because of perceived infant preference. All but one participant admitted to bedsharing. Three main themes emerged in their reasons for bedsharing. Participants felt 1) their baby is safer sleeping with them, 2) they wanted to maximize time with their baby, and 3) they were too tired to move the baby after a feeding. All participants agreed the messenger likely to affect behavior change for infant sleep in a public educational campaign would be a real parent or grandparent of a SUID victim. They felt that the most effective advertisement methods would be television, Facebook, and YouTube.

Conclusion: Most teenage mothers in this study reported practicing unsafe infant sleep practices, especially bedsharing, despite awareness of AAP recommendations. These participants believed that the most effective public educational strategy for their demographic would be a television, Facebook, or YouTube ad featuring a real parent or grandparent of a SUID victim.

0878

HOME SLEEPING CONDITIONS AND SLEEP QUALITY IN LOW-INCOME PRESCHOOL CHILDREN

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Introduction: We investigated associations between sleep environments and sleep quality in low-income preschool children.

Methods: Parents of preschool children in Head Start programs in Michigan (Detroit and greater Lansing) completed a questionnaire on children's sleep environments and also the Children's Sleep Habits Questionnaire (CSHQ). Parents reported how frequently (never to always) their child slept in different conditions (i.e., "too cold", "too hot", "too bright", or "too loud"); fell "asleep with the TV on"; co-slept with parent/sibling; shared a bedroom; or slept on a bed, floor, couch, chair, or floor mattress. Sleep quality was assessed by CSHQ total and subscale scores, for which higher values indicate worse sleep quality. Spearman correlations and stepwise multivariable linear regression models were used to examine associations between the CSHQ total score as the primary outcome and sleep environment features as primary explanatory variables.

Results: Among 120 preschoolers (mean age 4.1 ± 0.6 [SD] years) whose parents provided sufficient data, 63 (53%) were female and 54 (45%) were white. Stepwise regression models showed that higher total CSHQ scores (total $R^2 = 0.06$) were associated with falling asleep with the TV on ($\beta = 0.21$, $p = 0.02$) and inversely with sleeping in his/her own bed ($\beta = -0.24$, $p = 0.01$). Among CSHQ subscales, higher scores for bedtime resistance were associated with the frequency of sharing a room with parents during sleep ($\beta = 0.37$, $p = 0.01$, $R^2 = 0.14$), and higher scores for sleep onset delay (total $R^2 = 0.17$) were associated with sleeping in a place that was too bright ($\beta = 0.28$, $p = 0.002$) and falling asleep with the TV on ($\beta = 0.26$, $p = 0.005$).

Conclusion: These results suggest that adverse home sleep conditions among some low-income families are associated with worse sleep or sleep habits. If a causal relationship exists, amelioration of these sub-

optimal sleep conditions at home could offer an opportunity to improve children's sleep.

0879

THE RELATIONSHIP BETWEEN HISTORY OF CHILDCARE AND AGE OF CESSATION OF NAPPING IN PRESCHOOL AGED CHILDREN

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Introduction: Children's early sleep patterns are characterised by a gradual consolidation of night sleep and a subsequent reduction in daytime napping. Whilst normative data suggest that most children will cease napping prior to age four, there remains considerable variation in the age of napping cessation. One potential, and previously unexplored, predictor of napping cessation may be exposure to childcare services. Increasingly, centre based childcare represents a significant part of children's early life experiences. Despite the known reductions in napping in children beyond age two, sleep periods, and in some cases obligatory sleep periods, are a feature of many childcare curriculums right through to the time children enter school. This study examined whether history of childcare attendance is a predictor of age of napping cessation in preschool aged children.

Methods: Parent reports of child sleep patterns and detailed reports of history of childcare were analysed for $N = 667$ children aged 3-6 years ($M = 59$ months, 52% male). Participants were parents and children recruited to a large, longitudinal study of early childhood education and care experiences – E4Kids. A two stage hierarchical multiple regression analysis was performed with age of napping cessation as the dependent variable. In step 1 family SES (income and parent education) and child gender were entered, and in step 2 years of childcare was entered.

Results: A significant positive association was found between years in group based childcare and age of napping cessation ($r = .11$, $p = .002$). Once controlling for SES and child gender, the number of years attending ECEC was found to be a significant predictor of age of napping cessation, ($p = .01$).

Conclusion: This study is the first to demonstrate a relationship between history of childcare attendance and children's daytime sleep patterns. Increased time in childcare may delay cessation of napping in preschool aged children.

0880

THE ROLE OF SLEEP IN CHILDHOOD OBESITY: PERCEPTIONS AMONG LOW INCOME AFRICAN AMERICAN FAMILIES WITH OBESE CHILDREN

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Introduction: While there is extensive evidence of the role of sleep in appetite, metabolism, and weight, less is known about community awareness of the relationship between sleep and childhood obesity.

Methods: Eight African-American children and their caregivers participated in three focus groups sessions. All children were between the ages of 6 and 10 years, from low income families, and identified as overweight or obese (BMI > 85th percentile). Children and caregivers responded to questions pertaining to sleep including school night and weekend bedtimes and perceptions about the role of sleep in overall health and weight loss. Children only were asked about daytime fatigue. Focus group discussion was transcribed and analyzed using a qualitative methods software program to organize and code themes and patterns.

Results: While children generally felt sufficient sleep was important for health, they identified the mechanism of having sufficient energy to exercise and did not connect sleep with eating behaviors, appetite, or metabolism. Parents overwhelmingly discussed bedtime in the context of allowing them free time once children went to bed. Most child-reported bedtimes were too late to allow sufficient sleep and all children reported no weekend bedtime. The majority of children reported feeling tired during the day, particularly after school. In general discussions about obesity and healthy practices, children or caregivers did not mention sleep as contributory outside of responses to direct inquiries about sleep.

Conclusion: Families with obese children had little awareness of the complex relationship between sleep and obesity, beyond recognition of the role of sleep in having sufficient energy to engage in exercise. Child sleep patterns reported by children and caregivers suggested insufficient or disrupted sleep. Greater community awareness of the role of sleep in weight and overall health is needed.

Support (If Any): University of Louisville Department of Pediatrics Research Initiation Grant.

0881

A PILOT STUDY EXPLORING A RELATION BETWEEN VIDEO GAMES, SLEEP QUALITY, QUALITY OF LIFE, AND DEPRESSION IN TEENAGERS

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Introduction: The first video gaming system was introduced in 1972 with the Magnavox Odyssey. Since then, the gaming industry has exploded with a multitude of interfaces ranging from computers to smart phones. Gaming as a pastime is increasing with > 90% of Americans ages 6 years and older playing. Potential negative effects of gaming include sleep disturbances, as well as, aggressive behavior, attention difficulty, hyperactivity, academic and learning impairment, and obesity and poor eating habits. Studies outside the U.S. report that 3.4%-9% of players are addicted to gaming using DSM-IV symptoms including salience, mood modification, tolerance, withdrawal, conflict, and relapse. We hypothesize that some U.S. teens will meet criteria for video game addiction and that addiction will correlate with higher levels of depression, daytime sleepiness, and reduced quality of life.

Methods: Teens in an urban school district (grades 9-12) completed self-report surveys. Measures included the Problematic Online Gaming Questionnaire (POGQ), Cleveland Adolescent Sleepiness Questionnaire, Kutcher Adolescent Depression Scale (KADS), and Pediatric Quality of Life Inventory (PedsQL4.0). 2-tailed student t-tests were used to compare subjects whose POGQ scores suggested addiction and those who did not.

Results: To date, 745 surveys were distributed with a 50.8% return rate (n = 379). 42 teens (11%) met POGQ score criteria for video game addiction. There were more addicted males than females (n = 26 vs. 16, p = 0.004). The addicted group had significantly higher depression

(p = 0.001) and lower quality of life scores (p = 0.001) when compared to non addicted teens. After controlling for gender, daytime sleepiness was significantly higher (p = 0.003).

Conclusion: Our study found a higher prevalence of video game addiction than previously reported with a consistent male predominance. Addiction is associated with higher depression, lower quality of life, and increased daytime sleepiness scores. Further research and validation of the POGQ is needed.

0882

FACTORS ASSOCIATED WITH NIGHT-TO-NIGHT VARIABILITY IN SLEEP DURATION DURING ADOLESCENCE

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Introduction: Night-to-night variability of sleep variables derived from actigraphy or sleep diary data appears to be a novel risk factor associated with physical and mental health. However, little is known about factors associated with night-to-night sleep variability. The aim of this study was to assess the association of sociodemographic and behavioral factors with night-to-night variability in sleep duration in a general population sample of adolescents.

Methods: A sample of 421 adolescents (age 12-23 y, mean 17.0 ± 2.3 y; 53.9% male) from the Penn State Child Cohort underwent a 7 consecutive-nights actigraphy (GT3X) recording. We calculated within-subject 7-night mean total sleep time and its standard deviation (SD). The SD of total sleep time was used as an index of night-to-night variability in sleep duration. Prior to the actigraphy recording, self-reports on the Children Behavior Checklist, Morningness-Eveningness Scale, Tanner stage, and sleep patterns were obtained. Linear regression was used to examine the association of potential predictors with night-to-night sleep variability, controlling for age, gender, race, and socioeconomic status (SES).

Results: Older age ($\beta = .119$, p = .031), minority status ($\beta = .117$, p = .034) and lower SES ($\beta = .142$, p = .010) were significantly associated with higher night-to-night sleep variability, whereas gender ($\beta = .075$, p = .178) and Tanner stage ($\beta = -.005$, p = .927) were not. Independent of these potential confounders, externalizing behaviors ($\beta = .149$, p = .008), evening circadian preference ($\beta = -.234$, p = .0001), later bedtime on weekdays ($\beta = .134$, p = .049), and later waketime on weekends ($\beta = .291$, p = .0001) were associated with higher night-to-night sleep variability.

Conclusion: Social, behavioral, circadian, and lifestyle (weekend sleep patterns) factors appear to be associated with night-to-night variability in sleep duration in adolescence. Given the strong association of behavioral and life style patterns with night-to-night sleep duration variability, future studies focus on whether modifying/correcting these aberrant behavioral/life style patterns improve night-to-night variability, a novel risk factor for cardiometabolic morbidity.

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0883

SLEEP DISTURBANCE IN FAMILY CAREGIVERS OF CHILDREN WHO DEPEND ON MEDICAL TECHNOLOGY COMPARED TO FAMILY CAREGIVERS OF HEALTHY CHILDREN

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Introduction: Society relies on family caregivers of children who depend on medical technology (e.g., home ventilation) to provide highly skilled and vigilant care 24 hours per day. Few studies exist that have measured sleep in family caregivers, and those that do have relied entirely on subjective measures. These data suggest that sleep disruption places family caregivers at risk for poor health and related outcomes that may impair their daytime function and long-term capacity for caregiving. The primary aim of this study was to compare sleep and related outcomes in family caregivers of children who depend on medical technology to family caregivers of healthy children.

Methods: In a prospective cohort study (balanced per child's age) 42 family caregivers of children who depend on medical technology were recruited from a tertiary-level paediatric hospital and 43 controls from community-based paediatric clinics. Actigraphy was used for 6 days/7 nights and the PSQI was applied to collect sleep data. At home-visits, sleep diaries were collected and measures of depression (CES-D), sleepiness (ESS), fatigue (MAF), quality of life (SF-12©), sleep hygiene (SHI) and child's sleep quality (CSHQ) were administered.

Results: Family caregivers of children who depend on medical technology achieved 40 minutes less sleep per night (393.58 mins \pm 82.07 vs 433.08 mins \pm 33.15, $p = .007$), had more nocturnal awakenings ($p = 0.02$), and had more sleep deprived (< 6 hours) nights ($x^2 = 7.44$, $df = 1$, $p = .006$) than controls. Scores on sleep quality (PSQI) also differed (7.75 \pm 2.93 vs 5.45 \pm 2.77, $p = .001$). Other statistically significant differences were found in outcomes of depression, sleepiness, fatigue and child's sleep quality ($p < .02$).

Conclusion: This study confirms using objective measurement that family caregivers of children who depend on medical technology experience significant sleep deprivation and its negative consequences. Results of the study inform future sleep intervention studies with this vulnerable group.

Support (If Any): Canadian Respiratory Health Professionals; Canadian Lung Association, Ontario Respiratory Care Society; Ontario Lung Association, Norman Saunders Innovation in Complex Care Grant; Hospital for Sick Children Foundation.

0884

SUBOPTIMAL SLEEP ENVIRONMENTS AND DAYTIME BEHAVIOR IN LOW-INCOME ELEMENTARY SCHOOL CHILDREN

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Introduction: The association of sleeping environments with daytime behavior problems has not been reported previously. Therefore, we sought to examine the association between sleeping environments and daytime behavior problems in low-income elementary school children.

Methods: Parents of school-aged in Detroit, Michigan, $> 75\%$ of whom are enrolled in the free/reduced lunch program, completed questionnaires regarding children's sleeping environments and daytime behaviors. Parents indicated how frequently (1 = never; 5 = always) their child slept in a place "too bright", "too loud", "too cold", or "too hot". Suboptimal sleep environment (SSE) was defined as one or more adverse

conditions reported for ≥ 1 -2 nights/week. Daytime behaviors were assessed using the 27-item Conner's Parent Rating Scale-Short Version (CPRS). CPRS T-scores based on age and gender norms were generated. Wilcoxon tests were used to examine the association between SSE and daytime behaviors.

Results: Among 158 elementary school children (mean age 9.7 ± 0.13 [SD]), 66 (42%) were male and 138 (88%) were minorities. Parents reported that 52 (34%) of the children slept in a SSE at least one night per week. Median CPRS subscores were: Cognitive Problems/Inattention (48, 17 [interquartile range]); Oppositional (47, 15); Hyperactivity (50, 18); and ADHD (50, 17). Children with a SSE, in comparison to their peers, had higher median scores on oppositional (50 vs. 45, $p = 0.04$) and ADHD (53 vs. 47, $p = 0.02$) domains. Cognitive problems/inattention scores showed a trend toward higher values among children with a SSE (51 vs. 47, $p = 0.06$). Hyperactivity did not differ by sleep environment ($p = 0.15$).

Conclusion: At least once per week, about one-third of low-income elementary school children may experience a suboptimal sleeping environment, which may be associated with oppositional behavior and ADHD symptoms. If a causal relationship exists, public health implications of these findings could be substantial.

Support (If Any): Physician Scientist Training Award from the American Sleep Medicine Foundation.

0885

EXPOSURE TO HIGHER PHYSICAL WORK DEMANDS IS ASSOCIATED WITH SHORTER SLEEP DURATION IN HIGH SCHOOL STUDENTS COMBINING STUDY WITH PAID WORK

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Introduction: Young workers aged 15-24 years face high risk for injury while on the job. In adult workers, decrease in usual sleep duration was shown to increase the injury risk. This study aimed to explore the determinants of short sleep duration in high school students who work while studying.

Methods: Data come from the *Enquête interrégionale* survey based on representative samples of high school students aged 12-19 years from three regions of the province of Québec ($n = 3685$). All students completed a sociodemographic, school, work, life habits, and health questionnaire. A chi-square test was used to compare gender difference in work prevalence. A multiple linear regression was performed to identify factors associated with sleep duration.

Results: About three of ten high school students (29.4%) held a paid job in the month preceding the survey, excluding babysitting, seasonal work, and other odd jobs. There was no gender difference ($p = .32$). Almost three quarters of the jobs were in the sales and services sector. The R^2_{adjusted} (.546) for the linear regression model explains more than half of the variance in sleep duration of high school students who worked in the month preceding the survey. The 4 factors associated with a shorter sleep duration were later usual bedtimes ($\beta = -.66$, $p < .001$), a shorter weekend recovery sleep ($\beta = .12$, $p < .001$), exposure to higher physical work factors relating to carrying/handling of heavy loads and strain from using tools/machinery ($\beta = -.10$, $p < .001$), and female gender ($\beta = -.12$, $p < .01$). Age, social status, school-work conflicts, job dissatisfaction, and alcohol/drug consumption did not show a significant effect at the 5% threshold on sleep duration.

Conclusion: This study suggests that high physical work demands can contribute to sleep deprivation in students combining study with work.

Further research must confirm these findings and determine why female students who work are at greater risk of shorter sleep duration.

Support (If Any): This project was supported by an IRSST grant (0099-8820) awarded to L.L.

0886

THE FACTORS ASSOCIATED WITH CAREGIVERS' PERCEPTION OF INFANT SLEEP PROBLEMS IN TAIWAN

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Introduction: Previous study showed that parents' perception of infant sleep problems is different between Eastern and Western culture. Taiwanese parents were found to be more likely to report sleep problems in their children in comparison to other countries although the sleep condition of their children are similar. The aim of this study is to explore the factors associated with caregivers' perception of infant sleep problems.

Methods: 607 parents of infants aged from birth to 3 years (307 boys and 300 girls) completed a web-based online questionnaire about their children. The contents of the questionnaire include children's sleep pattern, demographic data (the factors of social culture environment), rating scales for parents' perception of infant's sleep (how distress they feel about different infants' sleep problem), the consistency of care attitude between couples and grandparents, Pittsburgh Sleep Quality Index (PSQI), Parents' Sleep Knowledge Inventory (PSKI), and Center for Epidemiologic Studies Depression Scale (CES-D).

Results: The results show that the infants' sleep measures can predict the level of distress of the parents about their children's sleep problem. Parents' sleep quality on the PSQI was found to be a mediator of the relationship between infant sleep and parents' level of distress. Parents' sleep knowledge measured by the PSKI serves as a moderator of the relationship between infant sleep and parents' level of distress. Sleep arrangement (co-sleep or not) serve as a moderator of the relationship between infant sleep onset and parents' level of care distress. The consistency of care attitude between couples and grandparents and parents' depression level measured by the CES-D were also found to be moderators of the relationship between infants' sleep onset after night awakening and parents' rating on night waking distress.

Conclusion: In conclusion, parents' sleep quality, sleep knowledge, the consistency of care attitude between couples and grandparents, emotion status are important factors on parents' perception of sleep problems in their children. These factors should be addressed in clinical intervention for infants' sleep problem.

0887

THE IMPORTANCE OF SOCIAL CONTEXT IN SLEEP PROBLEMS DURING ADOLESCENCE

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Introduction: Children's sleep is influenced by individual (e.g., ethnic background) and social factors (e.g., peers, SES). Evidence suggests that the quality of family relationships (Bordeleau, Bernier & Carrier, 2012; El-Sheik, Buckhalt, Mise, & Acebo, 2006) is associated with child sleep at through preadolescence (Bell & Belsky, 2008; El-Sheikh, Kelly, Bagley, & Wetter, 2013). As children age, the relative importance of relationships outside the home expands, raising the possibility that the larger social context (e.g., peer, school) may contribute to sleep problems. This study examined whether aspects of youths' larger social contexts predicted sleep in early to mid-adolescents, as well as variations by gender and race/ethnicity.

Methods: Analyses included data from the Study of Early Child Care and Youth Development collected in Gr. 6 ($n = 646$) and at age 15 ($n = 620$). Quality of the child's relationship with mother (conflict, positive), another adult (conflict, support), and peers (friendship quality), and child perceptions of the school (attachment, bonding) were entered by blocks in a multiple regression to examine the relative contribution of each context to child-reported sleep problems. We then examined whether the pattern of relationships differed by gender or race/ethnicity (White vs. Other).

Results: At both times, maternal, school and peer factors predicted sleep problems; no gender or age differences in the pattern of relationships were identified. The model was a better fit among girls (R^2 Gr.6 = .25; R^2 Age15 = .24) than boys (R^2 Gr.6 = .14; R^2 Age15 = .16), and for "Other" (R^2 Gr.6 = .34; R^2 Age15 = .38; than for White (R^2 Gr.6 = .12; R^2 Age15 = .17) youth.

Conclusion: Mother-child relationships continued to be meaningful predictors of sleep problems among early- and mid-adolescents. School and peer relationships were associated with sleep problems, particularly among girls and minority youth. These data represent a preliminary consideration of associations between distal social contexts with children's sleep.

0888

VALIDATION OF A POLYVINYLIDENE FLUORIDE IMPEDANCE SENSOR FOR RESPIRATORY EVENT CLASSIFICATION DURING POLYSOMNOGRAPHY IN CHILDREN

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Introduction: Polysomnography is the gold standard for investigating sleep disordered breathing and characterizing disease severity. Respiratory effort sensors such as the FDA approved polyvinylidene fluoride impedance belt (PVDFb) have proven to be equally affective to the current American Academy of Sleep Medicine (AASM) standard respiratory inductance plethysmography belt (RIPb) in adult polysomnographic recordings. PVDF detects changes in impedance and is less position-dependent compared to RIP sensors. We hypothesize that compared to RIPb, detection of respiratory events with PVDFb will allow for improved pediatric polysomnography interpretation, through decrease in artifact and increase in respiratory event recognition.

Methods: Patients ages 2-17 years undergoing polysomnography at our AASM-accredited sleep center were consented in this prospective, blinded study. Non-English speaking or patients with chronic disease that precluded safe participation were excluded. PVDFb and RIPb were placed on the child's chest and abdomen per manufacturer's guidelines. AASM based scoring by sleep medicine board certified physicians blinded to sensor type occurred via two separate montages. Epochs with respiratory sensor artifact were counted and percentage of artifact based on total sleep time (TST) calculated. Statistics include paired comparison using student's t-test.

Results: Of 6 subjects recruited, mean age was 9 years (± 3.3). Mean TST was 412 minutes (± 43). No difference in obstructive apnea, central apnea, or apnea-hypopnea index was found: 1.2 ± 2.9 , 0.8 ± 1.6 , 1 ± 1.1 , respectively. While not statistically significant, total hypopneas and artifact percentage was greater with RIPb compared to PVDFb: 4.7 ± 4.6 (22.6%) vs. 3.8 ± 4.5 (6.3%), respectively.

Conclusion: Given the absence of data comparing respiratory effort sensors and the importance of accurate event detection in PSG scoring and interpretation in pediatrics, our findings have important implications.

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0889

DEVELOPMENT OF INFANT AND TODDLER SLEEP PATTERNS FROM REAL WORLD DATA ON A MOBILE APP

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Introduction: The aim of this study was to investigate the development of infant and toddler sleep patterns across age.

Methods: Data were collected from users of a free publicly available app for the iPhone over a 19 month period. In the app, users can record sleep sessions of their child, including date, start time, and duration of sleep session. Sleep data were collected from 884 young children (408 girls, 476 boys; birth to 36 months), for whom at least 25 sleep sessions were recorded, for a total of 174,799 sleep sessions. This study was IRB approved and all users provided consent.

Results: This large data set allows for a detailed visualization of the development of sleep across the first three years. In the first three months, the majority of children had sleep sessions lasting less than 3.5 hours throughout the day. Between three and seven months, sleep consolidates into two naps of about 1.5 hours in length and a nighttime sleep session of about 10.5 hours of sleep. Across all age groups, a negative relationship is observed between the start of bedtime and the length of the nighttime sleep session (i.e., later bedtime is associated with a shorter nighttime sleep). The length of daytime sleep sessions (naps) varies with age, initially decreasing between one and five months, then increasing monotonically through 28 months. Morning wake time is observed to be invariant with child age from five to 36 months.

Conclusion: The use of an iPhone app to collect real world data from users was effective in generating a large longitudinal data set. While the general trends of infant sleep are found to be similar to previous research, this large data set allows a new level of detail on the developing infant sleep pattern.

Support (If Any): This study was supported by Johnson & Johnson Consumer Products Company, Division of Johnson & Johnson Consumer Companies, Inc.

0890

DIRECT COMPARISON OF FITBIT WITH POLYSOMNOGRAPHY AND ACTIGRAPHY IN CHILDREN AND ADOLESCENTS

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Introduction: The Fitbit is a commercially available accelerometer that reports to measure sleep quality and sleep duration. While it is less expensive than other brands of validated accelerometry (actigraphy), the validity and reliability of the Fitbit has not been assessed in pediatric populations. This study compared Fitbit to overnight polysomnography and concurrent actigraphy in children and adolescents.

Methods: Sixty-three patients 3-17 years (mean = 9.7 years, SD = 4.5, 49% male, 51% Caucasian, 44% Black) wore the Fitbit One Wireless Activity & Sleep Tracker (Fitbit, Inc., San Francisco, CA) on the non-dominant wrist during one night of polysomnography (PSG) at Children's of Alabama. Twenty-eight patients concurrently wore an actigraph (Phillips-Respironics Actiwatch Spectrum (PR-AS), n = 14; Ambulatory Monitoring Inc. Motionlogger Sleepwatch (AMI-MS), n = 14). Sensitivity, specificity, and accuracy were calculated from epoch-by-epoch comparisons; paired t-test was used to compare sleep duration and efficiency across devices; one-way ANOVA was used to examine differences in age groups.

Results: Due to technical issues with the Fitbit device (n = 12), PSG (n = 2), and actigraphy (PR-AS = 2), complete data were available for 49 patients. Compared to PSG, Fitbit sensitivity (.70) and accuracy (.71) were poor; Fitbit specificity was similar to or slightly higher than previous reports (.79). Compared to actigraphy (PR-AS and AMI-MS), Fitbit sensitivity was good (.92 and .95), but specificity (.27 and .39) and accuracy (.67 and .78) were poor. On average, Fitbit overestimated wake and underestimated sleep (PSG = 105 minutes, PR-AS = 117 minutes, AMI-MS = 84 minutes), resulting in a significantly lower sleep efficiency for Fitbit (62.6%) compared to PSG (83.4%), PR-AS (84.9%), and AMI-MS (82.2%), all $p < .001$. Significant age group differences were not found, however, Fitbit specificity was lower in adolescents (.71) compared to preschool (.84) and school-aged (.83) children, $p = .11$.

Conclusion: This is the first study to examine the reliability and validity of the Fitbit One to measure sleep-wake patterns in children and adolescents. The low cost, ease of availability, and web interface of the Fitbit make it a desirable device for pediatric sleep researchers and clinicians. However, this study demonstrates that it is not a reliable device for the estimation of sleep-wake patterns and sleep quality, significantly overestimating wake and underestimating sleep efficiency.

Support (If Any): This study was supported in part by NIH K23 MH066772 and the UAB Health Services Foundation General Endowment Fund.

0891

THE RELIABILITY AND VALIDITY OF THE CHILDREN'S SLEEP ASSESSMENT QUESTIONNAIRE

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Introduction: Sleep problems are common in school-aged children. Polysomnography is the gold standard of sleep measure, but it fails to identify behavioral sleep disturbances and related factors. Due to the multidimensional nature of sleep, a comprehensive tool to screen children's sleep problems and risk factors is needed. The Children's Sleep Assessment Questionnaire (CSAQ) was developed in this study. The reliability and validity of the CSAQ were tested in school-aged children in Taiwan.

Methods: A school-based sample including 3rd and 4th grade students was recruited from Taichung City in Taiwan. Two hundred and fifty-seven students and their primary caregivers administered structured questionnaires, including the CSAQ and the Pittsburgh Sleep Quality Index (PSQI) to assess students' sleep. The content validity, concurrent validity, construct validity, internal consistency, and stability reliability of the CSAQ were assessed. The PSQI served as the standard to assess the concurrent validity of the CSAQ.

Results: The CSAQ comprised two subscales, sleep hygiene (12 items) and sleep quality (13 items). The content validity index (CVI) score was 0.97 from 5 panel experts. The internal consistency reliability of Cronbach's alpha for the total scale and the subscales were 0.70, 0.55, and 0.67, respectively. The intraclass correlation coefficient (ICC) between students and their primary caregivers ranged from 0.37 to 0.44. The concurrent validity of the CSAQ sleep quality subscale was significantly correlated with the PSQI (Pearson correlation $r = 0.95$, $p < .001$). The result of the confirmatory factor analysis (CFA) supported the construct validity of the two CSAQ subscales ($\chi^2/df = 1.745$, RMSEA = 0.055).

Conclusion: The CSAQ is a valid and reliable instrument for assessing sleep problems in school-aged children.

0892

VALIDATION OF PEDIATRIC SLEEP QUESTIONNAIRE (PSQ) IN CHILDREN WITH DOWN SYNDROME*Rodriguez OM, Prosser JD, Ishman SL, Shott SR, Simakajornboon N*
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Introduction: Obstructive sleep apnea (OSA) is common in children with Down syndrome and can lead to several morbidities. Therefore, it is important to screen OSA in this population. The PSQ is a validated tool for evaluating OSA in children. Our goal was to validate the PSQ in children with Down syndrome.

Methods: This is a retrospective chart review of patients with Down syndrome ages 0-18 years. Only children who had completed PSQ and underwent PSG were included. All incomplete questionnaires were excluded. A PSQ was considered positive with a score of ≥ 0.33 based on previous validated studies. Two different AHI thresholds were used at $\geq 1/\text{hr}$ or $\geq 2/\text{hr}$ for an OSA diagnosis.

Results: Over a 6 year period, there were 91 questionnaires that met inclusion criteria. Average age for PSQ completion was 11.5 ± 7.9 years, and 52.7% of children were male. Average time between PSQ and PSG was 56.5 ± 45.7 days. The sensitivity and specificity of the PSQ to detect sleep apnea with an AHI $\geq 1/\text{hr}$ was 74% and 24% respectively. The positive predictive value (PPV) and negative predictive value (NPP) of the PSQ for an AHI $\geq 1/\text{hr}$ was 76% and 21% respectively. The sensitivity and specificity to detect sleep apnea with an AHI $\geq 2/\text{hr}$ was 77% and 30% respectively. The PPV and NPV for an AHI $\geq 2/\text{hr}$ was 62% and 48% respectively.

Conclusion: The sensitivity of PSQ in children with Down syndrome is comparable to previous studies but the specificity is low. The benefit of using the PSQ as a diagnostic tool for OSA in Down syndrome is very limited, although it may be used as a screening tool. As part of our quality improvement, we plan to prospectively evaluate the PSQ whether it is an effective tool in assessing clinical improvement after intervention.

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0893

DEXAMETHASONE DAMPENS CIRCADIAN REST-ACTIVITY RHYTHMS IN CHILDREN WITH LEUKEMIA*Rogers VE¹, Zhu S¹, Hinds PS²*¹Family & Community Health, University of Maryland-Baltimore, Baltimore, MD, USA, ²Children's National Medical Center, Washington, DC, USA

Introduction: Dampening of the circadian rhythm in adults with cancer is associated with greater fatigue, lower quality of life, and decreased time to relapse and death compared to patients with robust rhythms. Circadian rhythms during cancer treatment have not been studied in children. The aim of this study was to describe change in circadian rest-activity rhythms, measured by actigraphy, in children with acute lymphoblastic leukemia (ALL) before and during dexamethasone (DEX) chemotherapy.

Methods: This secondary data analysis included 82 children with low and standard-risk ALL. Children received intermittent pulses of DEX as part of maintenance chemotherapy. DEX was prescribed at 6 mg/m² on Children's Oncology Group protocols and 8 or 12 mg/m² on St. Jude Children's Research Hospital protocols. Children wore an actigraph for 10 consecutive 24-hour periods, 5 days before DEX (pre-DEX) and 5 days on DEX, and kept a sleep diary. Age group was dichotomized into 5-12 years (n = 72) and 13-18 years (n = 10). Circadian variables estimated from actigraph output were modeled with cosinor analysis, calculated by actigraph software, and averaged over each 5-day period. Variables included peak activity (highest activity count), amplitude (difference between peak and trough activity counts), MESOR (mean of peak and trough activity), circadian quotient (amplitude/MESOR) and

acrophase (clock time of peak activity). Higher values of the first four indicate more robust circadian rhythms.

Results: Mean age was 8.8 ± 3.3 years, 67% were male, 82% were Caucasian. Compared to pre-DEX, the mean values of rest-activity variables on DEX significantly decreased for amplitude, MESOR and peak activity (all $p < 0.01$), while acrophase advanced significantly by 17 minutes ($p < 0.05$). Circadian quotient showed no change. There were no significant differences in any circadian variable between age groups or sexes.

Conclusion: Initiation of DEX was associated with dampening of circadian rest-activity rhythms in children with ALL that did not differ by age or sex.

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0894

IMPROVEMENT OF SLEEP ARCHITECTURE IN DOWN SYNDROME CHILDREN AFTER A NUTRITIONAL COMPLEMENT*Haro RH*

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Introduction: Down syndrome (DS) is generally accompanied by sleep-disordered breathing. Many predisposing factors, including overweight and obesity have been described, however this population has not been well studied in terms of nutritional habits. The possible dietary involvement in the expression of chronic diseases is under study. Some reports postulated that sleep quality in DS improves after dietary interventions. The aim was to examine the effects of a dietary intervention in children with DS on their sleep structure.

Methods: Two overnight PSGs were done in two groups of DS children aged 4-13 years, belonging to a specialized school. Diet group (DG) took 20 grams of the formula twice a day during 3 months, (n = 24); PSGs were completed at the beginning and 3 months after continuous intake of the formula. A no diet group (NDG) of DS children (n = 18), and a control group (CG) of 30 matched healthy children with one PSG were included. Palatinose, serum protein, flaxseed, TruCal, and Nutraflora compose the formula. One-way ANOVA test was used to study differences between groups.

Results: SL, TST, SEI, N3 and REM sleep duration, and O₂ saturation values were shorter in DG and NDG compared to CG. These parameters improved in DG after 3 months of the intervention. Wakefulness, WASO, N1 and N2 duration, as well as sleep apnea index were higher in DG and NDG compared to CG. Sleep apnea index was severe in DS patients, and in spite of a significant improvement, it continued severe. Sleep improved in DG after the dietary intervention.

Conclusion: Differences in sleep parameters in DS children were found compared to healthy children. The dietary intervention improved the sleep architecture in DS children. More longitudinal studies controlling more variables such as changes in BMI are needed to know the effects of this or other alimentary complements.

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0895

EFFECTS OF A DIETARY INTERVENTION ON THE SLEEP PATTERNS IN CHILDREN WITH AUTISTIC SPECTRUM DISORDERS

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Introduction: There is growing interest in possible dietary involvement in the etiology and treatment of Autistic Spectrum Disorders (ASD). Research has focused on the physiological and behavioral effects of dietary changes. Some parental reports postulated that sleep quality in ASD improves after the intake of some alimentary complements. The aim was to examine the effects of a food complement formula in children with ASD on their sleep structure.

Methods: Two overnight PSGs were carried out in two groups of ASD children aged 3-13 years, belonging to a specialized school. The diet group (DG) took 20 grams of the formula twice a day during 3 months, ($n = 19$); PSGs were done at the beginning and 3 months after continuous intake of the formula. A no diet group (NDG) of ASD children ($n = 21$), and a control group (CG) of 30 matched healthy children with one PSG were included for comparative purposes. Palatinose, serum protein, flaxseed, TruCal, and Nutraflora compose the formula. One-way ANOVA test was used to study statistical differences between independent groups.

Results: TST, SEI, N3 and REM sleep duration, as well as O_2 saturation values were shorter in DG and NDG compared to CG. These parameters improved in DG after 3 months of the formula intake. Sleep latencies to N1 and REM sleep, wakefulness, WASO, N1 and N2 duration, as well as sleep apnea index were higher in DG and NDG compared to CG. Again these values showed a significant improvement in DG according to the second PSG.

Conclusion: We found significant differences in sleep architecture in ASD children compared to healthy children. The intake of a formula based in protein and micronutrients improved some sleep parameters affected in ASD children. Longitudinal prospective studies are necessary to know whether differences in PSG values are the result of this dietary intervention.

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0896

EFFICACY OF BEHAVIORAL INTERVENTIONS FOR PEDIATRIC INSOMNIA

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Introduction: The primary objective of this study was to conduct a meta-analytical review of the empirical evidence regarding the efficacy of behavioral interventions for the clinical management of pediatric insomnia.

Methods: Inclusion criteria for this review, based on Cochrane guidelines, included: (1) age of participants from 0 to 17.9 years; (2) behavioral or psychoeducational intervention involving behavioral principles for sleep initiation or sleep maintenance difficulties; (3) minimum sample size of 12 participants; (4) include at least one of four sleep outcome variables (sleep onset latency, number of night wakings, duration of night wakings, and sleep efficiency; and (5) published in English in a peer-reviewed journal.

Results: The final review was based on evidence from 28 studies ($n = 2,462$). Across the 14 studies that were controlled clinical trials involving typical children (birth to 18 years; $n = 1874$), there were significant effects for all four sleep outcomes ($Z = 4.69$ to 9.97 , $P < .001$) with small

to large effect sizes of standardized mean differences ($SMD = -0.20$ to 7.49). There were no significant effects found for the two studies ($n = 67$) conducted with special needs populations, $P > .05$. Finally, for the 12 studies ($n = 521$) that were within subject studies (baseline/post-treatment), there were significant effects for all four sleep outcomes ($Z = 4.90$ to 18.20 , $P < .001$) with large effect sizes ($SDM = 0.77$ to 4.83).

Conclusion: Overall, behavioral interventions were found to be efficacious for youth of all ages. There, however, continue to be large gaps in the literature, with future studies needed focusing on the efficacy of behavioral interventions for insomnia in adolescents, as well as children with special needs (e.g., ADHD, autism spectrum disorders).

0897

USABILITY FOR A WEB-BASED INTERVENTION FOR PEDIATRIC INSOMNIA

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Introduction: Despite the known impact of sleep loss on children and the existence of evidence-based behavioural interventions to treat Pediatric Insomnia, access to such interventions is limited. To address this translational knowledge gap, web-based interventions would allow for increased access to treatment. The objectives of the present study were to assess health professionals' perceptions of barriers and facilitators to the use of a potential web-based intervention for Pediatric Insomnia, and to collect feedback from health professionals and parents on an intervention that is currently being developed.

Methods: Part one of the study used an online questionnaire to ask health professionals about their perceptions of barriers and facilitators to the use of a potential web-based intervention. Part two of the study asked health professionals and parents to review and provide qualitative feedback on a web-based intervention that is currently being developed. Qualitative data were coded according to a model of behaviour change for internet interventions put forth by Ritterband et al. (2009).

Results: Health professionals ($n = 175$) most often listed time as a barrier (27.9%) and support as a facilitator (17.3%) to their use of a potential web-based intervention. In response to the intervention, there was much positive feedback by the 34 health professionals and 25 parents. Constructive feedback included technical issues (17.8%) and the burdens of the website (15.7% health professionals and 26.6% parents).

Conclusion: This study highlights the need for online interventions to be as brief and easy to use as possible and to be free of technical problems. The need for a concise and user-friendly website may be especially important for an intervention designed to treat pediatric insomnia, as the user has a child who is not sleeping well and therefore may have a limited amount of time and a high level of stress.

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0898

AN INSTITUTION'S EXPERIENCE—POLYSOMNOGRAPHIC STUDIES IN INFANTS UNDER 12 MONTHS OF AGE: DOES IT IMPACT TREATMENT?

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Introduction: Publications addressing the clinical utility of polysomnographic (PSG) studies for assessment in infants less than 12 months of age with suspected sleep disordered breathing (SDB) are limited. Clinically, our impression is that when SDB is identified in this age group, several obstacles frustrate the provision of optimal care. Given the increasing demand for PSG studies, cost and inconvenience of laboratory study to families; we sought to confirm that PSG testing in this age group provides additional important clinical information which impacts treatment. The purpose of this retrospective cohort study is to identify (i) characteristics of referred patients under 12 months of age, (ii) PSG findings and physician interpretation, (iii) treatment interventions, (iv) impact of treatment on clinical symptoms, if any, (v) feasibility of provision of optimal treatment.

Methods: Charts of infants less than 12 months of age referred for PSG at the Alberta Children's Hospital (ACH) from 2007 to 2012 inclusive were reviewed. Laboratory PSG measurements were performed according to the American Academy of Sleep Medicine guidelines.

Results: 104 patients met study criteria. Of the 50 patients reviewed to date, frequent comorbidities include trisomy 21 (36%), Pierre Robin (12%), achondroplasia (10%) and prematurity (10%). PSG findings are consistent with severe SDB. Comparison of treatment recommendation by PSG interpreting physician versus actual prescribed treatment showed 68% (95 CI [54.09, 79.24]) agreement. 23 patients (46%) were prescribed positive airway pressure (PAP) treatment. Compliance to prescribed therapy was only 29% in this population.

Conclusion: Despite PSG proven severe SDB and appropriate treatment recommendations, compliance with (PAP) therapy is poor in our population of infants under 12 months of age.

0899

THE RELAX TO SLEEP STUDY: A PILOT RCT

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Introduction: Hospitalization can contribute to common sleep difficulties in children. Interventions aimed at hospitalized children need to be developed and piloted with rigorous evaluative methods. The primary purpose of this study was to examine the feasibility and acceptability of a behavioral-educational intervention aimed at increasing nighttime sleep for hospitalized children.

Methods: A pilot RCT with concealed-group allocation was conducted. Forty-eight hospitalized children (ages 4-10) and their care-givers were randomized to either the RELAX TO SLEEP (RTS) intervention group (n = 24) or the Usual Care (UC) comparison group (n = 24). The RTS program included a discussion of children's sleep and sleep hygiene with a booklet, and a relaxation breathing (RB) technique for the child. UC participants received no information about sleep or relaxation. Children wore actigraphs for 3 days and nights and completed sleep diaries. Outcome measures included feasibility, acceptability, and sleep outcomes. Other outcomes measured at baseline and 7 days post-discharge included anxiety (Spence Children's Anxiety Scale), sleep habits (Children's Sleep Habits Questionnaire [CSHQ]), and post-hospital maladaptive behaviours (Post-hospital Behavior Questionnaire [PHBQ]).

Results: Of 68 families approached, 71% (n = 48) agreed to participate. Compliance was excellent as 86% (19/22) of RTS participants used RB at least once per day in hospital, and over half used it 2-3 times. Parental reports indicated they enjoyed the discussion about sleep, found the information helpful, and their child found RB easy to use, and would use it again in the future. Children in the RTS group averaged 50 minutes more of nighttime sleep (419 vs. 369.7 min, group difference 49.64 min, p = 0.085) and had improved CSHQ scores at follow-up compared to the UC group (-1.38 vs. 1.82, between group difference -3.20, p = 0.037). Compared to the RTS group, the UC group had more WASO (163.9 vs. 209.2, group difference -45.34, p = 0.182) and more daytime sleep (76.94 vs. 113.6, group difference -36.68, p = 0.121). There were no differences in anxiety or PHBQ scores.

Conclusion: The RELAX TO SLEEP program was feasible and acceptable. Further evaluation of the intervention with a definitive trial is needed.

Support (If Any): CIHR Sleep and Biological Rhythms Team Grant; Rosenstadt Doctoral Research Dissertation Award; Lawrence S. Bloomberg Faculty of Nursing, University of Toronto; SickKids Complementary and Alternative Health Care in Pediatrics Research Fellowship.

0900

SLEEP QUALITY AS A PREDICTOR OF INTERNET-DELIVERED BEHAVIORAL PAIN TREATMENT OUTCOMES IN ADOLESCENTS

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Introduction: Sleep is related to pain and functional outcomes in adolescents with chronic pain; sleep quality may be an important factor in treatment. However, sleep quality has rarely been studied in randomized controlled trials of pediatric pain interventions. This study aimed to determine the influence of pretreatment sleep quality on 6-month functional outcomes in adolescents with chronic pain receiving internet-delivered behavioral pain treatment. We hypothesized that poorer sleep quality at baseline would predict individual treatment response, that is, less improvement in physical function.

Methods: Participants included 211 adolescents (mean age = 14.7, SD = 1.6) in an ongoing study of internet-delivered treatment recruited from interdisciplinary pain clinics in the United States and Canada. Most participants were female (73.9%) and Caucasian (82.9%). Sleep quality was assessed via the Adolescent Sleep Wake Scale at baseline. Adolescents completed 7 days of online pain and function diaries, including items on the Child Activity Limitations Interview. Pre-treatment measures were completed before randomization to an education (online pain education) or treatment condition (online cognitive behavioral therapy for pain), while youth received usual pain clinic care. Adolescents (n = 137) repeated measures of pain and functioning at 6-month follow-up assessment.

Results: In a simultaneous regression model, as hypothesized, controlling for treatment group (B = .15, p < .05) and baseline activity limitations (B = .52, p < .0001), poorer sleep quality at baseline predicted treatment response (i.e., greater activity limitations at 6-months, B = -.22, p < .01).

Conclusion: Our preliminary findings indicate sleep quality may be an important predictor of long-term treatment outcomes in adolescents with chronic pain. Poor sleep quality may interfere with pain management skills acquisition or adversely influence coping, hampering improvement over time. Findings suggest that sleep assessment and treatment may be critical to incorporate into pediatric pain interventions.

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0901

QUALITY IMPROVEMENT PROJECT TO EVALUATE SCREENING OF SLEEP DISORDERS IN A PEDIATRIC POPULATION WITH HYPERTENSION

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Introduction: There is a reported association between hypertension, obesity and sleep disorders. In the Fourth Report of the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents published in *Pediatrics*, screening hypertensive children for sleep disorders was recommended. As a quality improvement project, we evaluated the implementation of this recommendation in our specific pediatric population in Birmingham, AL. Since sleep disorders can potentially increase the risk for cardiovascular disease, it is important to evaluate the frequency of sleep disorders in hypertensive children and the cost-effectiveness of performing polysomnography (NPSG).

Methods: A retrospective chart review identified pediatric patients at Children's of Alabama over the past few years who had ambulatory blood pressure monitoring (ABPM) and NPSG. We included patients who reported symptoms concerning for obstructive sleep apnea and had NPSG performed within 1 year of their ABPM.

Results: Fifty-four pediatric patients had both ABPM and NPSG. Out of these 54 patients, 33 had ABPM positive for hypertension. Diastolic, systolic or both pressures decreased less than 10% during the nighttime in 61% (20/33) of these patients. Of these 33, 17 patients were male (51.5%) and 21 (64%) were African American. The mean BMI was 33 and the mean sleep efficiency was 88%. Obstructive sleep apnea (OSA) was found in 54%, with severity ranging from mild in 7 children (21%) to moderate or severe in 11 children (33%). Four (12%) were found to have periodic limb movement disorder (PLMD).

Conclusion: In the hypertensive pediatric population studied at this institution, 54% of patients with positive ABPM were diagnosed with a sleep disorder (OSA \pm PLMD). These findings, within our specific patient population, support the recommendation to screen hypertensive children for sleep disorders. Obtaining NPSG on these children increases the identification of comorbid sleep disorders and is a cost effective practice.

0902

ATTITUDES, BELIEFS, AND PERCEPTIONS OF CAREGIVERS AND REHABILITATION PROVIDERS ABOUT DISABLED CHILDREN'S SLEEP

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Introduction: This qualitative study aimed to understand the attitudes, beliefs, knowledge, and perceptions about children's sleep hygiene among caregivers and rehabilitation providers of children with disabilities.

Methods: A total of 27 adults including 9 primary caregivers (8 were mothers) and 18 rehabilitation providers participated in five focus group discussions between September and December 2012 at the Rehabilitation Center in Punta Arenas, Chile. A trained facilitator guided focus groups discussions using a semi-structured script. Audiotapes and transcripts of the focus group discussions were reviewed and analyzed for recurrent themes.

Results: Focus group participants identified seven themes related to children's sleep hygiene: 1) lifestyle behaviors; 2) family factors; 3) children's disabilities and/or comorbidities; 4) environmental factors; 5) adults' responsibilities for children's sleep; 6) perception of good sleep; and 7) parental distress about children's sleep problems. While both caregivers and rehabilitation providers recognized the importance of sleep for children's health and functioning, they differed in their understanding of how sleep hygiene practices influence sleep. Rehabilitation providers recognized the negative influence of electronics on sleep and the positive influence of sleep routines. In contrast, caregivers reported use of television/movie watching and stimulants as coping strategies for managing children's sleep problems.

Conclusion: Caregivers need to better understand the influences of electronics and stimulant use on child sleep health. Rehabilitation providers are well positioned to provide educational messages to both children and caregivers in order to change their attitudes, beliefs, perceptions, and practices surrounding sleep. These qualitative data are valuable in developing intervention programs aimed at improving sleep health among children with disabilities.

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0903

POLYSOMNOGRAPHY FINDINGS IN OBESE CHILDREN < 8 YEARS OF AGE

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Introduction: Prevalence of obesity is estimated to be 11% of 2-5 year olds and 14% of 6-11 year olds. Obesity is commonly complicated by cardiovascular and metabolic dysregulation, and obstructive sleep apnea (OSA). Polysomnography (PSG) in obese young children has not been extensively characterized.

Methods: Retrospective chart review was conducted of obese children under 8 years of age who had a PSG during 2007-2013. Those with other co-morbidities contributing to obesity or OSA were excluded. Obesity was defined as body mass index (BMI) > 95th percentile for age on CDC growth charts. Data were investigated using Wilcoxon and Fisher's Exact test.

Results: 48 children were identified: 22 had a normal PSG (obese no-OA) and 26 had OSA (obese +OSA). In the obese no-OA and obese +OSA groups, the mean (SD) age was 5.3 years (+2.2) and 5.0 years (+2.3) respectively; the mean BMI z-score was 2.7 (+0.5) and BMI z-score 3.3 (+1.2) respectively (p = NS for both). The frequency of previous adenotonsillectomy in the obese no-OA and obese +OSA groups was 32% and 27% respectively; the frequency of asthma was 32% and 46% respectively (p = NS for both). In the obese no-OA and obese +OSA groups, mean sleep efficiency was 77% (+19%) and 83% (+/- 11.5%) respectively (p = NS); mean arousal index was 8.3/hour (+4.8) and 17.2/hour (+15.4) (p = 0.0006); mean obstructive apnea hypopnea index was 0.4/hour (+0.4) and 24.6/hour (+27.3) respectively (p = < 0.00001); mean sleep SpO₂ was 98% (+1%) and 96% (+3%) respectively (p = 0.02); mean sleep SpO₂ minimum was 87% (+7%) and 77% (+17%) respectively (p = 0.02); mean transcutaneous CO₂ maximum was 46.3 mmHg (+1.1) and 53.8 mmHg (+9) respectively (p = 0.003).

Conclusion: In this tertiary-referral, selected population of under-8 year olds, OSA was diagnosed in 54% of children. The diagnosis of OSA was not related to severity of obesity or concurrent asthma, and persisted despite adeno-tonsillectomy.

0904

SLEEP DISORDERS IN CHILDREN WITH IDIOPATHIC SCOLIOSIS

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Introduction: Physiologic changes during sleep exacerbate respiratory insufficiency during awake and predisposed patients with scoliosis to sleep disordered breathing (SDB). The purpose of this study is to assess SDB in children with idiopathic scoliosis and the correlation with lung function parameters, and scoliosis severity.

Methods: We conducted retrospective reviews of polysomnography and medical records of children diagnosed with idiopathic scoliosis from January 1, 2005 to March 31, 2013. Children with co-morbid neuromuscular disorders or incomplete records were excluded. The correlation between Cobb angle and SDB parameters & lung function parameters was calculated by linear regression analysis. T-test was used to calculate the difference in BMI in scoliosis children with OSA.

Results: 66 children met the criteria for entry into analysis. 22 patients with Cobb angle 70°. 28 of 66 patients (42.4%) in our cohort were diagnosed with OSA (OI ≥ 1/hr), 3 of 66 patients (4.5%) were diagnosed with central sleep apnea (central index > 5/hr), 7 of 66 patients (10.6%) were diagnosed with hypoventilation. The linear regression analysis revealed a negative correlation between Cobb angle and Forced vital capacity (FVC) ($p < 0.01$). There was also a trend toward significant correlation between Cobb angle and maximal end-tidal CO₂ ($p = 0.08$). There was no significant correlation between Cobb angle and AHI or obstructive index ($p = NS$). There was a significant higher BMI in scoliosis children with OSA (18.3 ± 5.5 [no-OSA] vs 23.4 ± 12.1 [OSA], $P < 0.05$)

Conclusion: Sleep disordered breathing including obstructive sleep apnea and alveolar hypoventilation is common in children with idiopathic scoliosis. As previously shown, there is significant correlation between scoliosis severity and changes in the lung function parameter. In addition, there is also a trend toward significant correlation between scoliosis severity and degree of hypoventilation, but there is no significant relationship between scoliosis severity and OSA. BMI seems to play a role in the occurrence of OSA in this population.

Support (If Any): Cincinnati Children's Hospital Research Fund.

0905

SLEEP DEPENDENT MEMORY CONSOLIDATION IN CHILDREN WITH AUTISM SPECTRUM DISORDERS

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Introduction: The consolidation of newly acquired memories depends on sleep and correlates with the number and density sleep spindles in stage 2 sleep (12-15 Hz) and slow wave activity (1-4 Hz) during stage 3 sleep. Sleep disturbances among children with autism spectrum disorders (ASDs) are a major clinical concern, but their effects on memory consolidation have not been reported. Here, we report the relations of sleep with overnight sleep dependent memory consolidation in children with ASDs compared to typically developing controls.

Methods: 22 children with ASDs (15 male; mean 11.4 years (± 2.1) and 20 control subjects (17 male; mean 12.3 years (± 2.2), $p = 0.7$ and $p = 0.8$) were trained on a 2D object location task to meet a criterion score

and then were given a cued test. Retest occurred after a 10 hour interval that consisted of either a period of wake during the day or a night of sleep with home-based polysomnography. All subjects participated in counterbalanced sleep and wake conditions. Memory consolidation was measured as testing compared to performance at the last training trial.

Results: Children with ASDs had poorer sleep efficiency than controls ($p < 0.001$) but there were no significant differences in macroarchitecture of sleep, sleep spindle density or slow wave activity. Both groups demonstrated better memory retention across the sleep than wake interval [$F(1, 74) = 5.27$, $p = 0.02$] controlling for age and nonverbal IQ but this effect was not different between groups ($p = 0.96$, sleep/wake \times group interaction). We found no significant correlations between task performance and measures of sleep efficiency, spindle density or slow wave activity in either group.

Conclusion: This is the first report showing that memory consolidation in children with ASDs is enhanced by sleep despite their reductions in sleep efficiency. Findings support the importance of sleep for strengthening memory in children with and without neurodevelopmental disabilities.

Support (If Any): Autism Speaks, Inc.; American Brain Foundation.

0906

EXCESSIVE SLEEPINESS AND NEUROCOGNITIVE PERFORMANCE IN CHILDREN WITH CRANIOPHARYNGIOMA

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Introduction: Pediatric craniopharyngioma patients are at increased risk for excessive daytime sleepiness (EDS) and deficits in neurocognitive functioning. We sought to preliminarily explore the relationships among EDS and neurocognitive variables in a sample of children with craniopharyngioma.

Methods: Prior to proton therapy, 32 patients with craniopharyngioma ages 5-19 ($M = 10.5 \pm 4.5$) underwent overnight polysomnography, multiple sleep latency testing (MSLT) and comprehensive neurocognitive assessments. 22 (69%) had undergone surgery beyond cyst aspiration or biopsy. Participants were 50% female and 69% Caucasian. Wilcoxon-rank sum tests were used to assess differences in neurocognitive measures between patients with mean sleep onset latency (SOL) \leq 10 minutes (EDS group) versus > 10 minutes (non-EDS) and those with < 2 versus ≥ 2 sleep-onset REMs (SOREM) on MSLT.

Results: 59.4% of the sample had a mean SOL of ≤ 10 minutes; 25% had ≥ 2 SOREM. Those with ≥ 2 SOREM had significantly lower verbal comprehension scores than those with < 2 SOREM ($M SS = 89.4 \pm 14.4$ vs. 103.8 ± 14.2 , $p < .05$). No significant differences were observed in any neurocognitive domains in the EDS vs. non-EDS groups. Qualitatively, the EDS group demonstrated 2/3 SD lower perceptual reasoning scores than the non-EDS group ($M SS = 106 \pm 18.1$ vs. 116.7 ± 20.5 , $p = .146$). The EDS group had omission rates on a continuous performance test nearly a full SD higher than the non-EDS group ($M T = 56.5 \pm 20.3$ vs. 47.7 ± 4.9 , $p = .278$).

Conclusion: Preliminary data in children prior to proton therapy for craniopharyngioma reveal that more than half present with EDS. Children with severe EDS demonstrated poorer verbal reasoning. Qualitative group differences reveal potentially greater sustained attention and nonverbal reasoning difficulties in children with craniopharyngioma who present with EDS prior to proton therapy. This will continue to be assessed in this population. A larger sample may provide more power to detect group differences.

Support (If Any): American Lebanese Syrian Associated Charities (ALSAC).

0907

OBESITY IS ASSOCIATED WITH POLYSOMNOGRAPHIC SLEEP DISTURBANCE IN ADOLESCENCE

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Introduction: Obesity in adults, even in the absence of sleep apnea, is associated with significant nighttime sleep disturbance compared to non-obese controls. Studies examining this association in adolescents, however, are limited. The aim of this study was to assess polysomnographic (PSG) differences in a general population sample of non-obese versus obese adolescents without sleep apnea.

Methods: A sample of 421 adolescents (ages 12-23 y, mean 17.0 ± 2.3 y; 53.9% male) from the Penn State Child Cohort, a representative general population sample, underwent a single 9-hour PSG recording. Height and weight were assessed and BMI percentile (BMI%) calculated based on the CDC's sex-specific BMI-for-age growth chart. Obesity was defined as $\geq 95^{\text{th}}$ BMI%. Subjects with an apnea-hypopnea index (AHI) ≥ 5 events/hour ($n = 44$) were excluded from the analysis. A general linear model examined the association of obesity with sleep onset latency (SOL), wake after sleep onset (WASO), total wake time (TWT), total sleep time (TST), sleep efficiency (SE), and percentages of stages 1, 2, slow-wave sleep (SWS) and rapid-eye movement (REM), controlling for age, gender, race, oxygen desaturation, and internalizing or externalizing behavior.

Results: A total of 327 adolescents were non-obese while 50 were obese. Compared to non-obese, obese adolescents showed significantly more WASO ($p = 0.026$), TWT ($p = 0.022$), and Stage 1 sleep ($p = 0.028$) and lower TST ($p = 0.022$) and SE ($p = 0.021$). There was also a trend towards less REM sleep ($p = 0.124$). SOL ($p = 0.197$), Stage 2 ($p = 0.51$), and SWS ($p = 0.60$) did not differ between obese and non-obese adolescents.

Conclusion: Similarly to adults, obesity in adolescence is associated with significant nighttime sleep disturbance, independent of sleep apnea. Future studies should examine the impact of objective sleep disturbances in obese on mental and physical health outcomes, as well as whether reducing these disturbances protects from these adverse health effects.

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0908

PREVALENCE OF PERIODIC LIMB MOVEMENTS DURING SLEEP IN NORMAL CHILDREN

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Introduction: There is a lack of community derived data regarding the prevalence of periodic limb movements during sleep (PLMS) in children. Previous studies based on clinical samples, such as children referred to sleep clinics or diagnosed with attention deficit-hyperactivity disorder, have estimated the prevalence of a PLMS index (PLMI) ≥ 5 /hour between 1.2 and 11.9%. However, normative data based on the general population are unknown. Therefore, the aim of this study was to determine the prevalence of PLMS in a sample of normal children.

Methods: 195 healthy, non-snoring children aged 5-17 years recruited from the community for research purposes underwent polysomnogra-

phy. Data were analyzed with descriptive statistics, t-tests and chi square tests as appropriate.

Results: The group age (mean + SD) was $12.4 + 3.1$ years, BMI z-score was $0.6 + 2.6$, and 58% were male. Sleep architecture was normal, and the obstructive apnea hypopnea index was $0.2 + 0.3$ /hour. PLMI median (range) was 0 (0-35.5)/hour. Fifteen participants (12 male vs. 3 female, $p < 0.0001$), aged $12.7 + 2.7$ years had PLMI ≥ 5 /hour, resulting in a prevalence of 7.7%. Five subjects had PLMI ≥ 10 /hour. Results were further analyzed by age: 100 school-aged children (5-12 years) and 95 adolescents (13-17 years). Five school-aged children, all male, had PLMI ≥ 5 /hour (prevalence 5%) vs. 10 (7 males, 3 females, prevalence 10.5%) adolescents ($p = 0.15$).

Conclusion: This study provides normative data to the field. Elevated PLMS were infrequent in this sample of normal children recruited from the community, but were more prevalent in males than females. However, there were no significant differences between younger and older children. Further research aimed at understanding the pathophysiology of PLMS in otherwise normal children is warranted.

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0909

POLYSOMNOGRAPHY AND MULTIPLE SLEEP LATENCY TEST FINDINGS IN CHILDREN WITH CRANIOPHARYNGIOMA PRIOR TO PROTON THERAPY

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Introduction: Sleep problems, such as excessive daytime sleepiness (EDS), are common in pediatric brain tumor patients. Craniopharyngioma patients are at risk due to the hypothalamic-pituitary-adrenal axis tumor location, hypothalamic obesity, and an aggressive therapy regimen. EDS and sleep-related breathing patterns have yet to be explored in this population at time of diagnosis.

Methods: Pediatric craniopharyngioma patients ($n = 37$) underwent overnight polysomnography and multiple sleep latency testing (MSLT) prior to starting proton therapy to assess for sleep disorders and daytime sleepiness. Age ranged from 3 to 19 years ($M = 9.59 \pm 4.79$), and the sample was primarily female (56.8%). Reported ethnicities were Caucasian (67.6%), African American (18.9%), Asian (2.7%), Other (2.7%) with 3 participants indicating multiple ethnicities (8.1%). 73% of the sample were overweight/obese with BMI z-scores ≥ 1 .

Results: On average, participants spent 514.62 ± 77.45 minutes in bed while only sleeping an average of 453.34 ± 83.01 minutes. Sleep efficiency scores ranged from 55.4 to 99.6 ($M = 89.04 \pm 9.48$). Mean apnea-hypopnea index (AHI) = 1.03 ± 1.18 with PLMI = 6.78 ± 10.60 . Results from the MSLT indicate the sample to be in the troublesome range for EDS (M SOL = 9.68 ± 5.43) with $n = 9$ (24%) having 2 or more sleep-onset REM episodes (SOREM). 17 (46%) were diagnosed with clinically significant EDS. 3 (8%) were found to have sleep disordered breathing. No differences were noted in sleep efficiency, AHI, or mean SOL based on obesity status.

Conclusion: Craniopharyngioma survivors have high rates of clinically significant EDS. This work demonstrates that nearly half of the children with this tumor present with clinically significant EDS and provides evidence for tumor- and surgery-related impairment of alertness. Longitudinal assessment is planned for this cohort to provide more information about the trajectory of sleepiness after proton therapy and guide alertness management interventions in this population.

0910

CYCLIC RESPIRATORY EVENTS IN PRESCHOOL CHILDREN ARE ASSOCIATED WITH A HIGHER HEART RATE THAN ISOLATED RESPIRATORY EVENTS

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Introduction: Previous analyses of the cardiovascular response to respiratory events, demonstrated that children frequently had cyclic events, precluding analysis of their events because a stable pre-event baseline could not be established. To establish the cardiovascular impact of these cyclic events, we aimed to quantify the effects on heart rate (HR) of cyclic and isolated respiratory events in preschool children.

Methods: These are preliminary data from 21 children (3-5 years) diagnosed with OSA by overnight polysomnography (PSG). Events were considered cyclic if there was < 25 s between two or more events. A ratio of the number of events that were part of a cyclic series to the number that were isolated was calculated and Pearson Correlations used to determine correlations between this ratio, and mean HR for each subject during wake, N1, N2, N3 and REM.

Results: Cyclic events ranged from 4 to 152/subject, and the number of cycles/subject ranged from 2 to 28. Isolated events ranged from 3 to 42/subject. Seventeen children had more cyclic events (mean 60 cyclic events vs 20 isolated events), one had an equal number (21) and three had more isolated events (mean 25 isolated events vs 16 cyclic events). The cyclic/isolated ratio ranged from 0.31 to 17, and was positively correlated with HR during N2 (Pearson Correlation = 0.5, $p = 0.02$), N3 (0.5, $p = 0.04$), and REM (0.5, $p = 0.02$).

Conclusion: Our data suggest that in the majority of preschool-aged children respiratory events do not occur in isolation but more commonly occur in close repetition as a mixture of obstructive and central events. A higher number of cyclic to isolated events correlates with higher mean HR. We speculate that the effect of cyclic events is more detrimental to the cardiovascular system than the effect of isolated events, and the impact of central events within these cycles should not be underestimated.

0911

SLEEP WAKE DISTURBANCES AND SEIZURES IN CHILDREN WITH DRAVET SYNDROME

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Introduction: There is a paucity of data focusing on sleep in specific epilepsy syndromes and their association with seizures. We aimed to describe the sleep-wake disturbances in children of Dravet Syndrome (DS), to compare the findings with age-gender matched controls, and to evaluate the relationship between sleep and seizures.

Methods: All were instructed to wear a wrist actigraphy to record rest and activity periods and to complete sleep diaries for at least 7 days. Subjective sleep quality and daytime function were evaluated by the Pediatric Sleep Questionnaire for Sleep-Disordered Breathing, and the Children Sleep Habit Questionnaire. Patients completed the seizure logs and the Quality of Life in Childhood Epilepsy Questionnaire.

Results: This is a study in progress. We have enrolled four participants (2 male patients, mean age 8 years old and 2 age-matched controls, 1 female and 1 male). Caregiver reported high amount of poor sleep quality, impaired daytime function, and lower quality of life in patients than in the controls. Actigraphy data of participants showed sleep-related parameters as follows; mean bed time (20:29 in patients vs. 22:12 in controls), wake time (07:58 vs. 06:49), time in bed (11.4 h vs. 8.6 h), sleep time (10.6 h vs. 7.5 h), sleep efficiency (92.7% vs. 87.3%) and wake after sleep onset (28.2 min vs. 52.8 min). Mean sleep latencies were 10.1 min in patients and 7.6 min in controls. Mean nap time of patients was 62.1 min, while no controls took naps. Frequent seizures were recorded exclusively during wake. Sleep-wake cycles, sleep time, and latencies on the days with seizures were not different from days without seizures. **Conclusion:** Sleep disturbances are common in Dravet Syndrome. Seizure occurrence appeared not to be related to their sleep-wake cycle. More patients are needed to clarify the association between sleep-wake cycle and seizures in DS.

0912

A PILOT STUDY OF SLEEP, STRESS, CORTISOL AND FATIGUE IN CHILDHOOD CENTRAL NERVOUS SYSTEM (CNS) CANCER SURVIVORS

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Introduction: The nature of cancer related fatigue (CRF) in school-age survivors is not well-known, particularly in early survivorship of CNS cancer. Research with adults suggests perceived stress and sleep behavior may be contributing factors. Unfortunately it is uncertain whether young CNS cancer survivors can complete biobehavioral instrumentation for a study of CRF. The purpose of this study was to test feasibility of outpatient saliva collection, child actigraphy, and behavioral surveys with young CNS cancer survivors and their parents prior to a larger study of the effect of sleep, stress, and salivary cortisol on CRF.

Methods: Five children age 8-12 yrs. with stable CNS cancer, post treatment 6 mo.-5 yrs. were recruited from a pediatric oncology clinic. Children donated a.m. and p.m. saliva for cortisol analysis, and completed perceived stress and fatigue (PedsQL) scales. Parents completed the Children's Sleep Habits Questionnaire (CSHQ). Children wore actigraphy wrist monitors for 1 week following the study visit.

Results: Of the 5 children, tumor location was posterior fossa (N = 4) and ventricular (N = 1); all had surgical resection, cranial radiation; 4 received chemotherapy. Mean CSHQ score was 46 of a possible 99 (higher scores indicating problems). Actigraphy revealed mean total sleep time 527 minutes; mean wake after sleep onset 41 minutes; and mean sleep efficiency 91% (N = 3; 2 participants excluded for scientific reasons per Respironics engineer). Mean perceived stress score was 138 (of a possible 500). Cortisol results revealed a diurnal pattern in 4 children. Mean subscale fatigue scores (higher scores up to 600 indicating less fatigue) were: 450, 440, and 455 (general, sleep/rest, and cognitive fatigue).

Conclusion: The proposed methodology is feasible for child CNS cancer survivors and their parents. Preliminary descriptive findings indicate possible dysregulation of sleep, stress, and cortisol in need of exploration in a large sample for correlation with fatigue.

0913

HYPERMOMNIA IN PEDIATRIC POSTURAL ORTHOSTATIC TACHYCARDIA SYNDROME

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Introduction: Patients with Postural Orthostatic Tachycardia Syndrome (POTS) exhibit symptoms like dizziness, chronic pain, difficulty con-

centrating and gastrointestinal disturbances. A common additional complaint is sleep disturbance, which has not been adequately characterized. The objective of this study was to evaluate hypersomnia in children with POTS.

Methods: The records of children and adolescents who had been diagnosed with POTS between January 2000 and September 2013, and had been referred for sleep consultation were reviewed. Subjects had undergone face to face consultation. Inclusion criterion included: 1) patients under the age of 19 years, 2) POTS diagnosis based on symptoms and an autonomic reflex screen (ARS) demonstrating an increase in heart rate of at least 30 beats per minute, 3) excessive daytime sleepiness, and 4) completion of a hypersomnia evaluation [actigraphy, nocturnal polysomnography and multiple sleep latency test (MSLT) as indicated].

Results: Of the 1441 patients diagnosed with POTS at our Institution, sixteen (1.1%) met the inclusion criterion. Fifteen (94%) were female. Eight of the 16 were diagnosed with a primary disorder of vigilance including 5 with idiopathic hypersomnia, 2 with narcolepsy and 1 with narcolepsy with cataplexy. All of these patients were female. Four of these 8 patients had an antecedent viral illness. The other 8 patients had non-specific fatigue.

Conclusion: POTS may present with hypersomnia in a small percentage of patients. While fatigue is the most common presenting complaint of POTS it is important to distinguish sleepiness from fatigue. Hypersomnia may be a risk factor for POTS with increased time spent in the supine position and associated deconditioning. We speculate that treating hypersomnia might improve outcomes in female patients with POTS.

0914

PREVALENCE OF PHOX2B MUTATIONS IN A COHORT OF CHILDREN PRESENTING WITH CENTRAL HYPOVENTILATION AND CLINICAL PHENOTYPE OF PHOX2B POSITIVE CHILDREN

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Introduction: Congenital Central Hypoventilation Syndrome (CCHS), a rare cause of hypoventilation, is diagnosed by the presence of a PHOX2B mutation and a characteristic clinical phenotype. Current reports show that 90% of CCHS cases will be heterozygous for polyalanine repeat mutations (PARM) and 10% will be heterozygous for a nonpolyalanine repeat mutation (NPARM). The Canadian Thoracic Society (CTS) recommends PHOX2B testing for unexplained central hypoventilation, but the prevalence of PHOX2B mutations among these children in the absence of cardiac, metabolic or neurological causes is unknown. Our aim was to determine the prevalence of PHOX2B mutations among a cohort of children with central hypoventilation for whom PHOX2B genetics were obtained.

Methods: We reviewed patients who had undergone genetic testing for PHOX2B between January 1, 2006 and December 31, 2012. Data was collected on patient demographics, reason for and results of PHOX2B testing as well as the patient's current status.

Results: Sixty-six children were identified. Thirty-three (50%) were male. Forty (60%) were tested due to hypoventilation and/or apneas, 6 (9%) due to family history of CCHS, 17 (26%) due to suspicion based on CCHS associations (ie. Hirschsprungs, neuroblastoma) and 3 (5%) were tested for other reasons. Of the 40 children tested for hypoventilation and/or apneas, 11 (28%) were found to have CCHS. There were 16 (24%) positive PHOX2B results; 9 (56%) PARM and 7 (44%) NPARM. Highest recorded median CO₂ (mmHg) for PHOX2B negative children and PHOX2B positive children were 52 and 85, respectively (p value = 0.0085).

Conclusion: In our review, 28% of children with hypoventilation referred for PHOX2B testing had a confirmed mutation. PARM and NPARM appeared to have similar prevalence and clinical phenotypes. PHOX2B testing should be performed in all patients who present with hypoventilation and/or apneas. In addition, a high CO₂ may be a positive predictive factor in diagnosing CCHS.

0915

SLEEP CHARACTERISTICS IN SURVIVORS OF CHILDHOOD MALIGNANCIES

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Introduction: Chronic illnesses including childhood malignancies can result in sleep perturbations that may impair learning, rehabilitation and quality of life. Sleep characteristics have been reported during treatment of childhood cancer and in adult survivors of pediatric malignancies but details of sleep in the early years after treatment have not been reported. We studied sleep characteristics in survivors of childhood malignancies in an inner city population in the three years after completion of treatment.

Methods: Sleep characteristics of childhood cancer survivors were prospectively assessed by responses to questionnaires administered to their parents and compared to responses from parents of healthy children matched for age, gender and ethnicity. Questionnaires included the Children's Sleep Habit Questionnaire (CSHQ), PedsQL Multidimensional Fatigue Scale (PedsQL Fatigue), Epworth Sleepiness Scale (ESS), and Pediatric Sleep Questionnaire (PSQ). Questionnaires were scored using standardized scales that assigned a numerical value to each answer.

Results: 17 survivors (8 male, 13 Latino) and controls, aged 10.2 ± 4.6 years and 10.0 ± 4.5 years respectively, were interviewed 14.9 ± 10 months after treatment. Total CSHQ (50.5 ± 7.6 and 48.1 ± 7.3), PedsQL Fatigue (74.8 ± 11.4 and 81.2 ± 11.1), ESS (6.6 ± 4.9 and 5.6 ± 3.5) and PSQ (4.4 ± 3.6 and 3.9 ± 2.7) were similar between the survivors and controls. However, CSHQ parasomnia subscale scores were significantly higher in survivors compared to controls (9.6 ± 2.5 versus 8.1 ± 0.8 respectively, p = 0.03) and PedsQL fatigue sleep/rest fatigue subscale scores were higher in subjects compared to controls (76.0 ± 13.6 versus 87.5 ± 12.9 respectively, p < 0.01). Specifically, subjects were more likely to sleep talk, have greater difficulty sleeping through the night and had problems with taking many daytime naps (all p < 0.05).

Conclusion: Childhood cancer survivors have a higher sleep/rest fatigue and parasomnias compared to the general pediatric population in the three years following the completion of treatment. Identification of specific problems in a timely manner may allow appropriate interventions to be provided to affected children.

0916

EFFECT OF SLEEP ON THE RECOVERY FROM PEDIATRIC MILD TRAUMATIC BRAIN INJURIES

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Introduction: Mild traumatic brain injury (mTBI)/concussion affects 1.8 million people per year in the United States. Although there is research on the link between mTBIs and sleep disorders, little evidence

has been presented correlating sleep disorders to mTBI recovery. The aim of this study was to investigate the effect, if any, of abnormal sleep on recovery time of pediatric mTBI patients.

Methods: This was a retrospective chart review of all pediatric patients presenting to the Concussion Clinic at the Cincinnati Children's Hospital Medical Center's (CCHMC) with the chief complaint of new-onset concussion between January 2008 and May 31, 2012. Charts were reviewed for sleep characteristics before and after the injury. The time to return to play (RTP) following the mTBI was the primary outcome measure.

Results: Of the 147 patients whose charts were reviewed, 74 were excluded from the study because they lacked detailed sleep information, presented to the concussion clinic more than 90 days after their injury, had more than 2 months between follow up visits, or had not yet been cleared to return to play. Seventy patients were able to be used in the study. Wilcoxon Rank Sum test used to compare time to return to play between those who had a worsening of sleep to those that did not have a worsening of sleep after the concussion showed that recovery took longer for those whose sleep had worsened after the concussion (Wilcoxon p-value = .025). The median return to play time for those who had worsened sleep was 6 weeks compared to the median return to play of 4 weeks for those who did not have worsened sleep after the concussion. These results were independent of age, gender, history of concussion or pre-existing sleep problems. Using a robust linear regression model, many sleep variables were analyzed. Hours of sleep after a concussion was the only variable approaching significance (p-value = .065). This model showed with every 2 hours of less sleep obtained (below 9 hours), RTP was increased by one week (p-value = .065).

Conclusion: The broad impact of sleep on attention, working memory, learning, and pain inhibition likely explains our results. Patients with mTBI often are recovering from headaches and cognitive deficits. Our results raise the question for future research of whether it may be more efficient to initially address sleep issues rather than to individually address the comorbidities of poor sleep in mTBI.

0917

PREVALENCE OF EPILEPTIFORM ACTIVITY IN CHILDREN LESS THAN 1 YEAR OF AGE REFERRED FOR POLYSOMNOGRAPHY

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Introduction: The prevalence of interictal epileptiform discharges (IED) in patients less than one year of age referred for polysomnogram (PSG) studies is unknown. We sought to determine the prevalence of IED in this patient cohort, raising the possibility that abnormal brain electrical activity or seizures may contribute to the sleep disorder. Specific aims of this study include (i) identify prevalence of IED in referred patients less than one year of age, (ii) quantify the number of IED, (iii) characterize sleep stage(s) during which IED occur, (iv) correlate the frequency and state in which the interictal discharges occur and the type of sleep disorder determined by PSG recording.

Methods: Charts of infants less than 1 year of age referred for PSG at the Alberta Children's Hospital (ACH) from 2007 to 2012 inclusive were reviewed. Quantification of IED was performed by a pediatric sleep neurologist for the entire study, unless there were greater than 20 IED within the first hour, in which case quantification was done for three 1 hour blocks (beginning, middle and end).

Results: 104 patients met study criteria. To date, the EEGs of 13 patients have been reviewed in detail. 5/13 had IED. 1 patient with infantile spasms had over 700 focal IED per hour. 98% of the IED occurred during stage 2 NREM sleep and 2% in REM sleep. 4 patients had less than 0.4 IED per hour. 8 patients had no IED.

Conclusion: Our preliminary data suggests a high prevalence of IED in medically complicated infants less than 12 months of age. More data is actively being collected to support this finding.

0918

HEART RATE VARIABILITY IN CHILDREN WITH RETT SYNDROME

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Introduction: Rett syndrome (RTT) is a progressive neurodevelopmental disorder associated with breathing perturbations and cardiac dysrhythmias that may contribute to sudden death. Sympathetic predominance of autonomic balance may predispose to dysrhythmias and can be demonstrated by higher ratio of Low Frequency power (LF) to High Frequency Power (HF) of heart rate variability (HRV). HRV is the change in interval between heart beats (RR) and LF/HF is derived from the spectral analysis of HRV. Higher LF/HF ratio has been reported in RTT based on analysis of wake EKG recordings. However, breathing in RTT is known to be irregular during wake and HF, which correlates with respiratory rate, is likely to be unreliable in these analyses. During sleep, breathing is more regular and the HF component can be reliably determined. The objective of this study was to evaluate autonomic balance during sleep in children with RTT from EKG tracings obtained during polysomnography.

Methods: We retrospectively compared HRV parameters including RR, LF, HF and LF/HF from EKG recordings of overnight polysomnography in children with RTT and matched healthy children with mild primary snoring. Analysis was performed in light sleep (N1 and N2), deep sleep (N3), REM sleep (R), and wake (W) in epochs free of respiratory events, arousals or excessive limb movements.

Results: 5 girls with RTT (8.6 ± 3.3 years) and 5 controls (8.5 ± 3.8 years) were studied. Children with RTT had shorter RR (higher heart rate) in light sleep and wake. In addition, children with RTT had higher LF/HF ratio in all stages compared to controls (3.93 ± 4.8 versus 0.22 ± 0.11 (N1 and 2), 2.69 ± 2.76 versus 0.13 ± 0.06 (N3), 3.63 ± 2.71 versus 0.42 ± 0.17 (R), and 3.36 ± 3.16 versus 0.49 ± 0.26 (W), all $p < 0.05$).

Conclusion: Children with RTT exhibit sympathetic predominance of the autonomic nervous system. Such findings may explain their reported risk for sudden death.

0919

PERIPHERAL VASOMOTOR CONTROL ACCORDING TO SLEEP STAGES IN PRETERM NEONATES

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Introduction: In contrast to animals or human adults during REM sleep, neonate's thermoregulatory responses are fully efficient in Active sleep (AS) but differ from those observed during the other sleep stages. The sleep stage effect on peripheral skin vasomotor control (PV), which is involved in homeothermia at thermoneutrality, is not well established. We analyzed in preterm neonates the sleep stage influence on PV, by the difference between internal (abdominal (Tabdo)) and foot skin temperature (T). Proximal and distal gradients (Tabdo- average proximal or distal T respectively) were also analyzed.

Methods: A PSG (EEGs, EOG, 8 p.m.-8 a.m.) was performed on 12 neonates (207 ± 10 days postmenstrual age, 1.435 ± 303 g birth weight,

9th night of life). Skin T were measured by infrared thermography on 10 body sites (abdominal; proximal: pectoral, shadows of the eyes; thighs; distal: hands and feet) every 5 minutes. PV (Tabdo-Tfoot), (Tabdo-Tdistal) and (Tabdo-Tproximal) were averaged over each sleep episode (n = 544: Wakefulness (W), Active, Intermediate (IS) and Quiet (QS) sleeps). **Results:** Results show that Tabdo-Tfoot was always higher than 1°C, indicating efficient PV, only in 8 out of the 12 neonates. Tabdo was stable and Tfoot more variable, featuring that skin PV is involved in the control of internal temperature. PV (Tabdo-Tfoot) and the other T differences (Tabdo-Tdistal; Tabdo-Tproximal) varied significantly between the sleep stages, with decreasing values from W to AS to QS and IS. The reverse was found when considering their variability (SD W > SD AS > SD QS and SD IS).

Conclusion: After 10 days of life, PV is efficient only in 8 out of the 12 preterm neonates. PV varies according to sleep stages, as do the other distal and proximal gradients, indicating PV overall body surface area. This observation reflects autonomic differences related to the sleep-wake cycle.

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0920

SLEEP DURATION AND PRESSURE PAIN RESPONSIVITY IN HEALTHY ADOLESCENTS

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Introduction: Bidirectional relationships have been found between sleep and pain sensitivity. In adult populations, there is evidence that sleep restriction is associated with increased pain sensitivity on experimental pain tasks. However, this relationship has not been examined in pediatric populations. This study aimed to evaluate: 1) the impact of restricted versus extended sleep duration on pain responsivity to pressure stimuli in healthy adolescents, and 2) the association between sleep duration and pain responsivity. We hypothesized that adolescents would report lower pressure thresholds and higher pain intensity during restricted sleep, and that restricted sleep would be associated with lower pressure pain thresholds after accounting for baseline pain frequency.

Methods: This pilot study included a subset of 19 adolescents between 14 and 17 years participating in a larger study of sleep and cognitive function. Participants completed a 3-week sleep manipulation protocol and two laboratory visits. The protocol included a baseline week, and randomization to either restricted sleep (6.5 hours in bed for 5 nights) or extended sleep (10 hours in bed for 5 nights) with subsequent cross over to the other sleep condition. At the end of each sleep condition, adolescents came to the lab to complete experimental pressure pain tasks in the lab. An algometer was applied 3 times to each site, the right and left forehead and the right and left palms, to a maximum pressure of 4 kg/m.s². Mean pressures were calculated from the 12 assessments.

Results: Although this was a sample of healthy adolescents, 73.7% reported baseline pain symptoms, with 6 (31.6%) adolescents who reported low-moderate pain intensity ≥ 2 times a week. Contrary to hypotheses, adolescents demonstrated similar pressure pain thresholds (2.77 kg/m.s² vs 2.72 kg/m.s²) and pain intensity (3.0 vs 2.7) after restricted and extended sleep manipulation. In a linear regression, sleep duration did not predict pressure pain thresholds, although the presence of pain ≥ 2 times a week significantly predicted decreased pressure pain thresholds (beta = .53, p = 0.02; F(3,5.87) = 0.007).

Conclusion: Our preliminary findings did not confirm the relationship between sleep duration and pain sensitivity identified in adults. However, the findings are hypothesis-generating and suggest that our future research will need to carefully consider youth's pre-existing pain history,

test multiple pain modalities (pressure, hot, cold), as well as consider a U-shaped association between sleep duration and pain sensitivity.

Support (If Any): NIH R01HL092149.

0921

THE EFFECT OF 36 HOURS OF SLEEP DEPRIVATION ON ADOLESCENT NEUROBEHAVIOURAL PERFORMANCE

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Introduction: This study investigates the effects of 36 hours of sleep deprivation on adolescent sustained attention, reaction speed, cognitive processing speed, and sleepiness.

Methods: Twelve healthy adolescents (6 male), aged 14-18 years (M = 16.17 years, SD = 0.83) spent 4 days and 3 nights at the sleep laboratory at the Centre for Sleep Research. Participants completed a neurobehavioural test battery, which included a 10-minute Psychomotor Vigilance Task (PVT), Digit Symbol Substitution Task (DSST) and Karolinska Sleepiness scale (KSS), every two hours during wakefulness. Repeated measures ANOVAs were used to compare baseline performance (defined as those test bouts between 0900 h and 1900 h on day 3, following two 10 hour sleep opportunities) to performance at the same clock time the day following total sleep deprivation.

Results: Sustained attention, reaction speed, cognitive processing speed, and subjective sleepiness were all significantly worse following one night without sleep, when compared to that following two 10 h sleep opportunities (all main effects of day, p < .05). Sleep deprivation led to increased variability for objective performance measures, but decreased variability in subjective sleepiness. There were between-subjects differences in response to sleep loss that were task-specific, suggesting that adolescents may not only vary in terms of the degree to which they are affected by sleep loss, but also the domains in which they are affected.

Conclusion: These findings suggest that one night of total sleep deprivation has significant deleterious effects upon neurobehavioural performance and subjective sleepiness. These factors impair daytime functioning in adolescents, and may leave them at greater risk of poor academic and social functioning, and accidents and injuries.

Support (If Any): This study was funded by a University of South Australia Divisional Research Performance Fund grant.

0922

PREVALENCE OF SLEEP DISORDERS AND ASSOCIATION WITH SCHOOL PERFORMANCE IN CHILDREN AGED 7 TO 9 YEARS

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Introduction: Several studies link sleep disorders (SD) in children with poor school performance (PSP). This problem can be avoided with treatment. Therefore, we performed a screening study to verify the prevalence of SD and investigate which of the SD were related to the school performance (SP).

Methods: We studied 1216 children aged 7 to 9 years from public elementary schools in Osasco. The children were selected by randomization. Written informed consent was obtained from the parents or guardians of all children. We excluded children with developmental syndromes, cleft lip and/or palate, those who had undergone tonsil and/or adenoid surgery, and those who were under or had a history of orthodontic or functional jaw orthopedic treatment. SP was measured by the grades obtained in Portuguese and Mathematics. The grade could not be lower than 5 in either of these disciplines for SP to be considered satisfactory. SD

were assessed using the “sleep disturbance scale for children” (SDSC), which was translated and culturally adapted to the Portuguese of Brazil. It consists of 26 questions about disorders of initiating and maintaining sleep (DIMS), sleep disordered breathing (SDB), arousal disorders (AD), sleep-wake transition disorders (SWTD), excessive somnolence (ES), and sleep hyperhidrosis (SHY), and was answered by parents or guardians.

Results: The prevalence of SD was: DIMS, 5.18%; SDB, 18.09%; AD, 1.56%; SWTD, 2.94%; ES, 3.29%; and SHY, 9.13%. The prevalence of PSP was 18.5%. Of SDB children 24% had PSP compared to 17% of non-SDB children ($p = 0.01$), of the ES children 33% had PSP compared to 18% of non-ES children ($p = 0.02$), and of SHY children 26% had PSP compared to 18% of non-SHY children ($p = 0.03$).

Conclusion: There is an association between PSP and the following SD: SDB; ES; and SHY.

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0923

VARIABILITY IN TOTAL WAKE TIME PREDICTS SUBSEQUENT PHYSICAL ACTIVITY LEVELS IN OVERWEIGHT/OBESE YOUTH

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Introduction: Sleep disturbance is an independent predictor of developing childhood overweight/obesity (OV/OB). Mechanistic studies have historically utilized mean sleep levels across-subjects to predict mean levels of weight-related behaviors (i.e., physical activity). However, day-to-day sleep variability may be a more sensitive index of disturbance and have more predictive power. This study examined the relationship between total wake time (TWT) and physical activity (PA) in OV/OB youth over 7-days at both the between-subjects level (do mean levels of TWT predict mean levels of PA) and within-subjects level (does nighttime TWT predict PA levels the following day).

Methods: OV/OB children ($n = 135$; 8-12 years old) wore a Sensewear Armband continuously for 7 consecutive days. This multi-sensor device provided minute-by-minute estimations of activity level and sleep/wake status. PA was defined as the number of minutes spent in moderate to very-vigorous activity, and the sleep variable of interest was TWT.

Results: Between-subjects and within-subjects fixed effects were assessed using multilevel modeling, with TWT predicting PA. Analyses revealed that mean TWT did not predict mean levels of PA in the fixed between-subjects model ($\beta = .19$, $t(132.19) = 1.23$, $p = .222$); however, nightly variation in TWT did significantly predict PA the following day in the fixed within-subjects model ($\beta = -.10$, $t(606.25) = -1.99$, $p = .047$). Thus, nights characterized by more minutes spent in TWT were characterized by days spent in fewer minutes of PA.

Conclusion: This study found that night-to-night variability in TWT was a more powerful predictor of PA the following day than mean TWT was in predicting mean PA in a sample of OV/OB youth. Specifically, nights that children experienced greater TWT than was normal for them were followed by days spent in fewer minutes of PA than was normal for them. These findings suggest that greater variability in children's sleep may exert a greater influence on physical activity levels than consistently poor sleep.

0924

SLEEP AND CIRCADIAN PHENOTYPES AMONG OFFSPRING OF BIPOLAR PARENTS: ASSOCIATION WITH CONVERSION TO BIPOLAR DISORDER

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Introduction: Disruptions in sleep and dysregulation in circadian functioning may represent core abnormalities in the pathophysiology of bipolar disorder. However, we do not know whether these abnormalities are related to the onset of bipolar disorder. This report compared sleep and circadian phenotypes among three groups: offspring of bipolar parents diagnosed with (BP/OBP) and without (non-BP/OBP) bipolar disorder and offspring of matched control parents who did not have bipolar disorder (controls). Among the non-BP/OBP children, we examined the association of sleep and circadian phenotypes with conversion to bipolar disorder over longitudinal follow-up.

Methods: Pittsburgh Bipolar Offspring Study youth (BIOS) (ages 6-18) and their parents completed assessments every two years pertaining to child sleep and circadian phenotypes, using the School Sleep Habits Survey (SSHS), and current psychopathology. Mixed-effects models controlling for within-family correlations compared the offspring groups on sleep and circadian variables, and converters and non-converters on the same factors.

Results: Parent ($n = 632$) and child ($n = 513$) reports of child sleep showed that BP/OBP youth differed from controls on parent-reported measures of sleep quality (all $p < 0.047$). While other sleep and circadian phenotypes differentiated the three groups, these differences did not remain when controlling for mood symptomatology and comorbid diagnoses. Parental ratings of child's sleep quality ($p < 0.005$) and child's weekend time in bed ($p < 0.007$), and child ratings of sleep onset latency ($p < 0.006$) were associated with later conversion to bipolar disorder in non-BP/OBP.

Conclusion: Disturbed sleep occurs in OBP, even if they are not diagnosed with BP. Still, significant differences between the groups were not observed when controlling for comorbid diagnoses. Additionally, sleep disturbance may be a prognostic indicator of the development of bipolar disorder in high-risk youth. Objective measures of sleep and circadian phenotypes may be more sensitive than self-reports, and should be utilized in future work.

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0925

THE RELATIONSHIP BETWEEN SLEEP QUALITY IN PREADOLESCENT AND PARENT: A CHINESE POPULATION STUDY

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Introduction: Although adolescent sleep has been extensively investigated as a key indicator of bio-psychological status in relation to health outcomes, few have looked at the sleep pattern of preadolescents and even fewer have examined the relationship between sleep quality in preadolescents and parents. The aims of this study were twofold: to investigate the sleep quality during preadolescence; and examine the associations between preadolescent sleep and parent sleep in China.

Methods: This cross-sectional study represents a sub analysis of the China Jintan study of 807 preadolescent-parent dyads enrolled June-July

2013. Sleep quality was assessed using a Chinese version of the Pittsburgh Sleep Quality Index (PSQI).

Results: The mean age of preadolescents in this study was 13.01 ± 0.93 years old. 5.5% of the preadolescents reported hypnotic medication use, 19.4% perceived poor sleep quality and 21.2% reported median or high level of dysfunction due to sleepiness. The prevalence rates of poor sleep quality were 20.84% for boys and 18.42% for girls ($\chi^2 = 0.75$, $p = 0.39$). The rate of poor sleep quality in group without co-sleepers (27.05%) was statistically higher than co-sleeper group (18.39%) ($\chi^2 = 4.90$, $p = 0.03$). Correlations were statistically significant for global sleep quality, sleep duration and perceived sleep quality ($r = 0.08$ - 0.16 , $p < 0.05$) in the dyads. The PSQI global score in fathers was associated with the PSQI global score in the preadolescent ($r = 0.19$, $p = 0.04$), whereas the PSQI global score in mothers was associated with perceived sleep quality, sleep disturbances, sleep latency and PSQI global score in the preadolescent ($r = 0.09$ - 0.18 , $p < 0.05$).

Conclusion: This study indicates that poor sleep quality and daytime dysfunction (due to sleepiness) are prevalent during preadolescence in China. Preadolescents and parents have significant but relatively weak correlations in sleep quality. Results from this study support the need for future research to examine the relationships in sleep quality among preadolescents, mothers and fathers; and to evaluate the efficacy of familial interventions for sleep disturbances.

0926

SLEEP VARIABILITY AND ABDOMINAL OBESITY IN ADOLESCENTS: THE PENN STATE CHILD COHORT

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Introduction: Chronic sleep problems in adults have been associated with abdominal obesity and cardiometabolic disorders. However, associations between habitual sleep patterns and central obesity have not been fully understood, especially in adolescents. We investigated the associations between habitual sleep duration and its variability and body fat distribution in population-based adolescents of the Penn State Child Cohort (PSCC).

Methods: An actigraph (GT3X) and a sleep diary were used in 421 adolescents for 7 consecutive nights to calculate each individual's nightly sleep time and sleep efficiency. We then calculated within-subject 7-night means and the standard deviations (SDs). The means being used as the individual's habitual sleep duration and efficiency. The SDs were used as the individual's habitual variability of sleep duration and efficiency. Body fat distribution was assessed using a standardized Dual-energy X-ray Absorptiometry (DXA) system, including Android/Gynoid Fat Ratio, Android/Total Body Fat (%), and Gynoid/Total Body Fat (%). Linear regression models were used to evaluate the relationships between habitual sleep variables and the body fat distribution variables.

Results: The mean (SD) age was 16.7 y (2.3), with 52% male and 78% white. The mean (SD) of habitual sleep duration and its variability were 7.00 h (0.83) and 1.16 h (0.58) hrs. The mean (SD) of habitual sleep efficiency and its variability were 83% (6.3) and 7.01% (4.3), respectively. After adjusting for age, gender, race, and BMI percentile, 1-h increase in sleep-duration-variability, but not mean sleep duration, was associated with higher Android/Gynoid Fat Ratio ($\beta = 0.02$, SE = 0.01, $p < 0.05$), and higher Android/Whole body Fat Ratio ($\beta = 0.21$, SE = 0.10, $p = 0.05$). Neither habitual sleep efficiency, nor its variability were significantly associated with body fat distribution variables.

Conclusion: In adolescents, higher habitual night-to-night sleep-duration-variability, but not mean sleep duration, is significantly associated with abdominal fat distribution. Habitual night-to-night sleep variability is a novel risk factor associated with cardiometabolic morbidity.

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0927

EVENING AND MORNING SALIVARY CORTISOL ASSOCIATED WITH POLYSOMNOGRAPHIC SLEEP DISTURBANCE IN ADOLESCENCE

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Introduction: Increased activity of the hypothalamic-pituitary-adrenal axis has been associated with significant nighttime sleep disturbances in adults. However, studies examining this association in adolescents are very limited. The aim of this study was to assess the association of salivary evening and morning cortisol levels with polysomnographic (PSG) parameters in a general population sample of adolescents.

Methods: A sample of 421 adolescents (age 12-23 y, mean 17.0 ± 2.3 y; 53.9% male) from the Penn State Child Cohort underwent a single 9-hour PSG recording. PSG parameters of sleep onset latency (SOL), wake after sleep onset (WASO), total wake time (TWT), total sleep time (TST), sleep efficiency (SE), and percentages of stages 1, 2, slow-wave sleep (SWS), and rapid-eye movement (REM) were ascertained. Saliva samples were collected in the evening (7 PM) and in the morning (7 AM) during the in-lab study. Samples were assayed for cortisol and values were logarithmically transformed as they were not normally distributed. Linear regression was used to examine the association of salivary cortisol levels with PSG variables, controlling for age, gender, race, and body mass index percentile.

Results: Higher evening cortisol levels were significantly associated with higher SOL ($\beta = .105$, $p = .035$), WASO ($\beta = .122$, $p = .013$), and TWT ($\beta = .135$, $p = .006$) as well as lower TST ($\beta = -.128$, $p = .010$), SE ($\beta = -.133$, $p = .007$), and percent REM marginally ($\beta = -.080$, $p = .105$) but not with percent stages 1 ($\beta = .060$, $p = .221$), 2 ($\beta = .040$, $p = .372$), or SWS ($\beta = -.009$, $p = .839$). Morning cortisol levels were not significantly associated with PSG parameters ($\beta = .014$ -. 102 , all $ps > .270$).

Conclusion: Similar to adults, increased evening cortisol levels are associated with significant nighttime sleep disturbance in adolescence. The association of sleep disturbance with HPA axis activation in adolescence suggests that chronic sleep problems may have an adverse impact on physical and mental health in young individuals.

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0928

SLEEP VARIABILITY AND NUTRITION INTAKE IN ADOLESCENTS: THE PENN STATE CHILD COHORT

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Introduction: The association between habitual sleep patterns and nutrition intake is not fully understood, especially in adolescents. We investigated the association between habitual sleep duration and its vari-

ability with nutrition intake in population-based adolescents of the Penn State Child Cohort (PSCC) follow-up examination.

Methods: An actigraph (GT3X) and a sleep diary were used in 421 adolescents for 7 consecutive nights to calculate nightly sleep time and sleep efficiency. We then calculated within-subject 7-night means and the standard deviations (SDs). The means being used as the individual's habitual sleep duration and efficiency. The SDs were used as the individual's habitual variability of sleep duration and efficiency. Dietary habits and nutrition intake were assessed using a validated youth/adolescent food frequency questionnaire. Total intakes of energy (kcal), protein (g), fat (g), and carbohydrates (g) were analyzed. Linear regression models were used to evaluate the relationships between habitual sleep variables and the nutrition intakes.

Results: The mean (SD) age was 16.7 y (2.3), with 52% male and 78% white. The mean (SD) habitual sleep duration and its variability were 7.00 h (0.83) and 1.16 h (0.58), respectively. The mean (SD) habitual sleep efficiency and its variability were 83% (6.3) and 7.01% (4.3), respectively. After adjusting for age, gender, and race, 1-hour increase in sleep-duration-variability, but not mean sleep duration, was associated with higher total energy intake ($\beta = 201.38$, $SE = 64.45$, $p < 0.01$), higher total fat intake ($\beta = 6.38$, $SE = 2.50$, $p = 0.01$), and higher carbohydrates intake ($\beta = 32.18$, $SE = 8.79$, $p < 0.01$). Similarly, higher sleep-efficiency-variability, but not mean sleep efficiency, was significantly associated with higher energy, total fat, and carbohydrates intakes.

Conclusion: In adolescents, higher habitual sleep-duration-variability and sleep-efficiency-variability are associated with higher total energy intake, especially energies from fat and carbohydrates. These associations may contribute to obesity associated with sleep. Night-to-night sleep duration variability is a novel risk factor for increased food intake and obesity.

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0929

INSOMNIA SYMPTOMS IN THE TRANSITION BETWEEN CHILDHOOD AND ADOLESCENCE: A LONGITUDINAL STUDY

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Introduction: Cross-sectional studies show that insomnia symptoms are the most prevalent parent-reported sleep problem in childhood and that adolescents report an even higher prevalence. Little is known about the natural history of insomnia symptoms and its predictors in the transition between childhood and adolescence.

Methods: The Penn State Child Cohort is a general population sample of 700 children aged 5-12 years (8.6 ± 1.7 y) at baseline of whom 421 (53.9% male) were followed up 8 years later during adolescence (17.0 ± 2.3 y). All subjects underwent a 9-h polysomnography and medical history and parent-reported scales at baseline. Insomnia symptoms were defined as parent-reported difficulty falling (DFA) and/or staying (DSA) asleep at baseline and as self-reported DFA and/or DSA at follow-up.

Results: The rate of incident insomnia symptoms in adolescence was 31.2% and it was higher in females ($OR = 1.8$, $p < .05$) and those with childhood psychiatric/behavioral problems ($OR = 2.8$, $p < .01$). Childhood externalizing and internalizing behaviors were associated with incident insomnia symptoms, with tension being the best predictor ($OR = 1.02$, $p < .05$). The rate of persistent insomnia symptoms was 48.2% and was higher in females ($OR = 3.6$, $p < .01$), minority ($OR = 4.1$, $p < .01$), heavier subjects ($OR = 1.05$, $p < .05$), or those with childhood psychiatric/behavioral problems ($OR = 3.0$, $p < .05$). Childhood

polysomnographic parameters, including apnea-hypopnea index, were not associated with the natural history of insomnia symptoms.

Conclusion: The incidence and persistence of insomnia symptoms in the transition between childhood and adolescence is high and similar to that found throughout adolescence and middle-age. Gender differences appear during this transitional period, while behavioral problems are an independent predictor of insomnia symptoms development and persistence. Sleep disordered breathing does not predict the natural history of insomnia symptoms during this transitional period.

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0930

ROLE OF SHORT SLEEP DURATION, SLEEP DISTURBANCES, AND EMOTIONAL DISTRESS ON WEIGHT GAIN IN THE TRANSITION BETWEEN CHILDHOOD AND ADOLESCENCE

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Introduction: Previous studies have shown that short sleep duration is associated with weight gain in children. However, few studies have accounted for sleep disturbances and emotional distress, which have been associated with obesity.

Methods: The Penn State Child Cohort is a general population sample of 700 children aged 5-12 years (8.6 ± 1.7 y) at baseline of whom 421 (53.9% male) were followed-up 8 years later during adolescence (17.0 ± 2.3 y). Of those, 380 had complete 9-h polysomnography (PSG), anthropometric, and parent-reported Pediatric Behavior Scale (PBS) data at baseline. Baseline short sleep (i.e., "sleeps less than most other children"), sleep disturbance (i.e., "sleep is restless or disturbed"), and emotional distress (i.e., anxiety T score) were ascertained with the PBS. Weight gain was defined as follow-up body mass index (BMI) percentile minus baseline BMI percentile (i.e., α BMI percentile). Linear regression, controlling for gender, age, and race, was used to analyze the data.

Results: Mean age was 8.7 y (1.7) and mean α BMI percentile was 2.4 (22.8), with 54% male and 76% white. Mean PSG sleep duration was 463.2 min (42.5) and anxiety was 51.4 T score (11.3), 19% with short sleep, and 38% with sleep disturbance. Baseline short sleep ($Beta_{SS} = .124$, $p = .016$), sleep disturbance ($Beta_{SD} = .116$, $p = .024$), and anxiety ($Beta_{ANX} = .156$, $p = .002$) were associated with α BMI percentile, whereas baseline PSG sleep duration was not ($Beta_{PSG} = .043$, $p = .410$). However, short sleep did not remain significantly associated with α BMI percentile after controlling for sleep disturbance ($Beta_{SS} = .096$, $p = .078$) and further controlling for anxiety ($Beta_{SS} = .084$, $p = .120$). Anxiety remained significantly associated with α BMI percentile ($Beta_{ANX} = .129$, $p = .015$).

Conclusion: Weight gain in the transition between childhood and adolescence is associated with emotional distress and sleep disturbances. Treatment efforts to prevent weight gain in children should target emotional distress and sleep disturbances rather than short sleep duration per se.

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0931

THE EFFECT OF DEPRESSION ON CARDIOVASCULAR FUNCTIONING DURING SLEEP IN ADOLESCENT GIRLS

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Introduction: Depression is an established independent risk factor for cardiovascular disease in adults. Recent literature suggests preclinical signs of cardiovascular risk are also present in depressed adolescents. No study has examined the effect of depression on cardiovascular factors during sleep in adolescents. The aim of this study was to examine heart rate (HR) and blood pressure (BP) in depressed versus healthy adolescents during wakefulness and sleep.

Methods: Eighteen girls (13-18 yrs; 8 clinically depressed, 10 control) recruited through Australian secondary schools took part in a clinical interview followed by an overnight assessment in a sleep laboratory. Polysomnography was conducted with continuous beat-to-beat finger BP and HR monitored via Portapres and ECG, respectively. Data were analysed as an average of the first 6 hours of sleep as well as 2-minute epochs of stable sleep averaged within sleep stages. To investigate the blood pressure dipping response, further analyses of 30-second epochs were averaged across pre-sleep wakefulness and the first ≥ 5 minutes of continuous stable Stage 2 in the sleep onset period.

Results: T-tests revealed depressed adolescents had significantly higher BPdiastolic, BP systolic and Mean Arterial Pressure (MAP) across the entire night ($p < 0.01$). Two (depressed, control) \times four (Wake, NREM1&2, SWS, REM) repeated measures ANOVA also revealed a significant main effect for group in BP systolic, BP diastolic and MAP with depressed girls showing consistently higher BP (~ 11 mmHg) across all stages ($p < 0.001$). Depressed adolescents also displayed a blunted BP systolic decline at sleep onset compared with controls ($p < 0.05$). No other group*stage interactions were found to be significant and no significant group differences were found in HR.

Conclusion: Depressed adolescent females were found to have significantly higher BP during sleep compared to controls as well as a blunted dipping response. This suggests that depression has a significant chronic effect on the cardiovascular system during sleep in adolescents, which may increase risk for future cardiovascular pathology.

0932

PRELIMINARY RESULTS FROM AN EXAMINATION OF SLEEP, PSYCHOLOGICAL DISTRESS AND FREQUENCY OF SUBSTANCE USE IN SUBSTANCE-ABUSING ADOLESCENTS

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Introduction: Substance-using adolescents often present with co-occurring insomnia and psychiatric symptoms. It is often unclear from a clinical perspective which of these variables to focus on as the primary target of treatment. It is also unclear if engaging in sleep or mental health treatment should be deferred pending resolution of substance use. The purpose of this study was to examine the independent contributions of insomnia and mental health distress in predicting increased substance use.

Methods: Participants were 32 adolescents with complaints of sleep disturbance or daytime sleepiness who were completing or had recently completed outpatient substance abuse treatment. Cross-sectional, baseline data were examined from a behavioral sleep intervention study (Bootzin & Stevens, 2005). Sleep was measured via the daily sleep diary. Recent marijuana, alcohol, and nicotine use and general mental health

distress were measured via the gold-standard Global Appraisal of Individual Needs interview.

Results: Using the conservative Sobel statistic, a trend was observed demonstrating that sleep onset latency partially mediated the relationship between mental health distress severity and a greater number of days cigarettes were smoked (Sobel test = 1.38, $p = 0.08$ one-tailed). A similar effect was not observed when reversing the order of predictors with mental health distress as a mediator. There were no data to support either insomnia or mental health distress as mediators of alcohol or marijuana use, although there was a trend suggesting that increased mental health distress was associated with more days of alcohol use ($B = 0.73$, $SE = 0.44$, $p < 0.10$).

Conclusion: These preliminary data suggest that clinicians aiming to reduce cigarette use in adolescent substance users may benefit from first addressing insomnia rather than mental health distress. There were minimal direct contributions of insomnia to alcohol or marijuana use, but this may have been affected by the small sample size. Future longitudinal studies are necessary to validate these cross-sectional findings.

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0933

PARENTAL SLEEP PRACTICES DURING INFANCY ARE ASSOCIATED WITH SLEEP PROBLEMS IN CHILDREN WITH GENERALIZED ANXIETY DISORDER BUT NOT CONTROLS

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Introduction: Research suggests that parental over-involvement in infant sleep routines is associated with fragmented sleep and difficulty learning to self-soothe but few data exist linking these early parenting behaviors to children's later sleep patterns. Since up to 90% of children with generalized anxiety disorder (GAD) endorse sleep problems, we compared sleep-related child and parent behaviors during infancy between parents of children with GAD and control children and examined associations with sleep problems during the school-age years.

Methods: A total of 77 children between the ages of 7 to 11 ($M = 8.83$, $SD = 1.38$) participated, including 44 children with a primary diagnosis of GAD and 33 matched healthy controls without medical or psychiatric disorders. The Anxiety Disorders Interview Schedule for Children/Parents (ADIS-C/P) was administered to all participants. Parents also completed a retrospective questionnaire regarding sleep-related practices when children were 0 to 6 months of age and the Child Sleep Habits Questionnaire (CSHQ). Children completed the Sleep Self-Report (SSR).

Results: Compared to controls, children with GAD were significantly likely to have colic (12% vs. 28%, respectively) and more likely to breastfeed right before sleep (38% vs. 64%, respectively). In the GAD group, parent report of sleep problems was significantly associated with being rocked to sleep and nursing right before bed in infancy, while child-reported sleep problems were significantly associated with frequency of co-sleeping. These relationships were not observed among controls.

Conclusion: Findings are among the first to document differences in some, but not other infancy-based sleep behaviors among parents of clinically-anxious and non-anxious children and to link these early practices to high rates of sleep problems in childhood. Consistent with previous research however, we found evidence of temperament \times environment interactions, suggesting certain early parenting behaviors may only be problematic for some (i.e., anxious) children.

0934

FREQUENT NIGHTMARES IN CHILDREN WITH GENERALIZED ANXIETY DISORDER: PRIMARY, SECONDARY, OR PRESUMED PHENOMENA?*Reynolds KC, Grochett C, Alfano CA*

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Introduction: Nightmares are considered normative developmental phenomena, but are linked with anxiety in children. Although 3-5% of children report frequent nightmares (Hublin et al, 1999; Nerveus et al., 2001), 55-81% of children with generalized anxiety disorder (GAD) report frequent nightmares (Alfano et al., 2006; Alfano, Ginsburg & Kingery, 2007). Clinically, the role of nightmares in childhood GAD is unclear. First, frequency data are based on only parent-report of nightmares. Second, as trait anxiety is positively associated with nightmare frequency (Mindell & Barrett, 2002), nightmares may directly correspond with early levels of generalized anxiety and worry. Increased frightening/stressful events among anxious youth may similarly increase risk of nightmares, and other features of childhood GAD may create vulnerability for nightmares. For example, high levels of bedtime resistance/refusal, nighttime fears, and co-sleeping behaviors among children with GAD may produce increased arousal at bedtime and increased nightmares. The current study sought to address these research gaps.

Methods: First, the nightmare prevalence was compared in children with primary GAD (n = 40) and matched healthy controls (n = 40), ages 7-11 years, based on retrospective and prospective child and parent reports. Second, correlational and regression analyses examined specific correlates and predictors of nightmares in both groups.

Results: Findings indicated GAD children experienced significantly more nightmares than controls based on retrospective parent report only ($F = 11.637$, $p < .001$); only co-sleeping significantly predicted a portion of the variance in parent reported nightmares, followed by marginal results for sleep-related anxiety and bedtime resistance ($p = .06$ and $p = .06$, respectively).

Conclusion: Overall, results suggest differences in nightmares according to parents that were only partly explained by greater frequencies of co-sleeping and sleep-related fears in children with GAD. Findings are considered in terms of the role of sleep in early-onset GAD, and whether sleep-related fears may pave the way from sleep problem to later anxiety.

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0935

RESTRICTED VERSUS IDEALIZED SLEEP AND CHANGES IN EMOTIONAL FUNCTIONING IN HEALTHY TEENS*Talavera DC, Reddy R, Jackson C, Melodina S, Grochett C,**Alfano CA*

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Introduction: Experimental studies have shown negative changes in affect after sleep deprivation but data are primarily limited to adult samples. The current used an experimental sleep restriction protocol to test relationships between sleep duration, anxiety and mood in a sample of healthy adolescents.

Methods: N = 30 healthy adolescents between the ages of 13 to 17 ($M = 15.05$, $SD = 1.43$) were randomly assigned to a Restricted (4 hours) or Idealized (9.5 hours) sleep condition following one week of normal sleep assessed with actigraphy. At baseline and on the day following sleep manipulation adolescents' completed a battery of measures including the Epworth Sleepiness Scale (ESS), State Trait Anxiety Index (STAIC), and the Positive and Negative Affect Schedule for Children (PANAS-C).

Results: A two-way repeated measures ANOVA revealed a significant main effect for negative affectivity, $F(1, 28) = 6.22$, $p = .019$, indicating

a decrease in negative affectivity for all teens at the second assessment. Similarly, there was a significant main effect for positive affectivity, $F(1, 26) = 22.85$, $p = .00006$, with decreases in positive affectivity observed in both groups. A significant Group \times Time interaction also emerged, $F(1, 26) = 11.07$, $p = .003$, showing a significant increase in state anxiety among the Sleep Restricted group only.

Conclusion: Findings are consistent with previous research showing inadequate sleep among teenagers to result in adverse changes in emotional functioning. These data suggest that restricting sleep during adolescence has a robust effect on anxiety. Inadequate statistical power and/or teens' difficulty with adhering to an 'idealized' sleep regimen may have impacts results for negative and positive affect. Findings are considered in terms of their implications for future studies and early intervention efforts.

0936

THE CO-OCCURRENCE OF INSOMNIA AND ANXIETY AND ASSOCIATED FACTORS AMONG PEDIATRIC PATIENTS IN THE UNITED STATES*Matsuno RK, Harding B, Kadakia A, Wallace L*

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Introduction: Little is known regarding the co-occurrence of insomnia and anxiety in the pediatric population. The association between a dual diagnosis, stratified by which condition was diagnosed first, and patient characteristics and treatments has also been unclear.

Methods: This retrospective cohort study used commercial claims data from MarketScan. Patients diagnosed with primary insomnia or primary anxiety at age ≤ 16 years were included. Multivariable Cox regression models were used to estimate the association between selected factors and the risk of a dual diagnosis.

Results: Among patients diagnosed with primary insomnia, 10.8% were subsequently diagnosed with anxiety; while among patients diagnosed with primary anxiety, 4.3% were subsequently diagnosed with insomnia. Whereas both psychiatric disorders and prescriptions for SSRIs were more common in insomnia patients with than without a dual diagnosis (30.5% versus 19.4%, and 24.7% versus 5.1%, respectively), this was not seen in anxiety patients with dual diagnosis, who were more likely to have prescriptions for 'other' antidepressants (11.1% versus 3.8%). Among insomnia patients, females had a greater risk of a subsequent anxiety diagnosis ($HR = 1.25$, 95% CI 1.19-1.31) and risk increased with age ($HR = 4.78$, 95% CI 4.40-5.19 for age 12-16 versus age < 6); in contrast, there were no differences in risk of insomnia diagnosis by sex or age for anxiety patients. Insomnia patients with fibromyalgia, asthma, GERD, a psychiatric disorder, or an autism spectrum disorder were at increased risk for anxiety whereas patients with epilepsy were at decreased risk. Anxiety patients with fibromyalgia, restless leg syndrome, and epilepsy were at increased risk for insomnia.

Conclusion: A dual diagnosis was more common among patients who were initially diagnosed with primary insomnia. Demographic, comorbidity, and treatment factors associated with a dual diagnosis differed among patients with initial insomnia versus anxiety diagnoses.

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0937

PEDIATRIC CONTINUOUS POSITIVE AIRWAY PRESSURE ADHERENCE ENHANCED WITH FAMILY MEMBER USE

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Introduction: Adherence to positive airway pressure (PAP) therapy for obstructive sleep apnea syndrome (OSAS) remains a significant challenge especially in children. We sought to determine whether having a household “role model” for PAP therapy (parent, sibling, other family member) predicts better adherence.

Methods: We assembled a retrospective cohort of 78 children less than 18 year of age evaluated in our pediatric sleep center (January 2011 to June 2013) with a new diagnosis of OSAS and successful CPAP titration. Predictors included patient characteristics and PSG /PAP findings. Outcomes were objective adherence at 1 week, 1 month and 3 months. Of 78 children who met eligibility criteria, 21 (27%) children were excluded from analysis (4 refused therapy, 17 had no recorded use).

Results: Fifty-seven children in the final analytic sample had mean age 13 ± 6 yrs, were 62% male, 64% African-American, 71% obese and 29% with intellectual disabilities. Mean obstructive apnea hypopnea index (oAHI) was 27 ± 33 and 24% had split night studies. Mean use was 3.4 ± 2.7 hrs/night at 1 week, 2.8 ± 2.3 hrs/night at 1 month, and 2.7 ± 2.4 hrs/night at 3 months. The presence of a household member using PAP was associated with higher average nightly hours of use ($P = 0.02$) at 3 months and a greater percentage of nights with more than 4 hr use ($P = 0.03$) at 3 months. Split night study was associated with a greater percentage of nights used at 1 month ($P = 0.02$). Greater use at week 1 correlated with higher use at 3 months. Greater adherence was associated with younger age and higher maternal education but not associated with sex, race, developmental delay or severity of OSAS.

Conclusion: Our novel findings of positive impact of having a family “role model” for PAP use may inform future interventions to improve PAP adherence in children.

0938

GENETIC DENTAL AGENESIS OR ENVIRONMENTAL DENTAL EXTRACTION AND PEDIATRIC SLEEP-DISORDERED BREATHING

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Introduction: Genetic factors are suggested as risk factors for development of pediatric sleep-disordered breathing (SDB). Oral facial development is under the control of homeobox genes including those involved in dental-alveoli growth such as *Msx1* and more specific the *DLX* genes with a homeocode transmitted from rodent to human unchanged (chromosome 7). Specific mutations lead to specific dental agenesis. But functions are as important as genes in impacting on facial growth after birth.

Methods: We systematically search for children with dental agenesis or early in life extraction of permanent teeth—usually lateral pre-molars or incisors—in 2 databases (orthodontic practice and sleep clinic), and reviewed all clinical information available including complaints, evaluation, pediatric sleep questionnaire, polysomnogram-PSG. We identified 31 children and our search also 16 young adults ($n = 47$) with agenesis. Due to collaboration, all children and young adults had been seen in sleep clinic due to association of high-narrow hard palate and at

least 1 symptom associated with SDB. However, parents waited up to 10 years to obtain recommended PSG with regular orthodontic follow-up over time. Nine 8-12 year old children were identified with at least 2 permanent teeth extraction, 4 associated with head-gear treatment post extraction.

Results: All individuals presented with high narrow hard palate, maxillary deficiency with or without mandibular retrusion, mouth breathing, Mallampati scale 3 or 4. Complaints were fatigue, school problems: inattention, difficulty to focus, hyper-activity (2 classified as ADHD), agitated and poor sleep, sleepiness ($n = 20$), nocturnal sweating ($n = 16$), NREM parasomnia ($n = 8$) with no difference between agenesis and extraction individuals. PSG results: AHI between 4 and 12 and mean lowest oxygen saturation: $91 \pm 1.2\%$ but flow limitation always above 60%Total-Sleep-Time (mean 78%).

Conclusion: The alveolo-dental growth site is involved in facial growth during fetal and post-natal life as other syndrochondroses. Genetic or environmental impairments lead to impact on facial growth, with change in breathing and secondary development of SDB symptoms.

0939

RISK FACTORS FOR INCIDENT SDB IN ADOLESCENTS: PENN STATE CHILD COHORT

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Introduction: Waist circumference, nasal problems and minority have been previously identified as risk factors for sleep-disordered breathing (SDB) in elementary school children in a representative population sample. The purpose of this study was to identify risk factors for incident SDB in an adolescent sample derived from this same cohort 8 years later.

Methods: The Penn State Child Cohort is a representative random sample of 700 children aged 5-12 years (8.6 ± 1.7 years) at baseline. Of these subjects 421 have been followed up 8 years later as adolescents (17.0 ± 2.3 years). All subjects completed a 9 hour PSG and a DXA scan. SDB was defined as an apnea-hypopnea index ≥ 5 .

Results: At baseline the prevalence of SDB was 1.2%. At follow up 100% had remitted with an incidence of 10.5%. We assessed 28 potential risk factors observed at follow up and age ($P < 0.001$), male ($P = 0.025$), waist ($P < 0.001$), chronic sinusitis/rhinitis ($P = 0.115$) and thyroid disease ($P = 0.126$) were identified as potential ($P < 0.20$) risk factors. At baseline 11 additional potential factors were considered including: tonsil size; tonsil inflammation; AHI ≥ 1 ; palate length; chronic sinusitis/rhinitis; wheeze and allergies. None of these factors reached the criteria for potential risk factor ($P < 0.20$). The final logistic regression model for males included age [$\beta = 0.583$, $P = 0.004$] and Δ waist ($\beta = 0.698$, $P < 0.001$) and for females age [$\beta = 1.334$, $P = 0.001$] and sinusitis ($\beta = 2.668$, $P = 0.002$). We further assessed central obesity in more detail in males and observed that visceral fat was a risk factor for incident SDB ($\beta = 1.457$, $P = 0.008$).

Conclusion: Risk factors for incident SDB in adolescents were strongly associated with age and the gender distribution shifted towards male, which indicates that SDB in young children is not in a continuum with adolescent or young adult SDB. As in middle-age, central obesity appears to be the main risk factor for SDB in male adolescents.

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0940

TREATMENT PROVIDES LONG TERM IMPROVEMENTS IN SLEEP DISORDERED BREATHING SEVERITY AND SLEEP PARAMETERS IN PRESCHOOL CHILDREN

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Introduction: Adenotonsillectomy is the most common treatment for obstructive sleep apnoea (OSA) in preschool-aged children, however the limited research investigating the outcomes in this age group have had short follow-up periods. We aimed to compare sleep and respiratory parameters 3 y following treatment in preschool-aged children (3-5 y).

Methods: All subjects underwent overnight polysomnography at baseline and follow-up. At baseline, children were grouped into Control (n = 10, obstructive apnea hypopnea index (OAHI) ≤ 1 event/h, no history of snoring), Primary Snoring (PS, n = 15, OAHI ≤ 1), Mild OSA (n = 8, OAHI 1-5), Moderate/severe OSA (MS, n = 10, OAHI > 5) and at follow-up, into Control (n = 10), treated (n = 19: PS, n = 5; Mild OSA, n = 4; MS OSA n = 10) or not treated (n = 14; PS, n = 10; Mild OSA, n = 4) groups. Sleep and respiratory variables were compared between studies using two way repeated measures ANOVA.

Results: Preliminary data from 43 children (33 SDB, 10 controls) shows a reduction in OAHI in the treated group (p < 0.001) and no change in the not treated and control groups between studies. Of the children with PS, 80% of treated children still had PS and 20% worsened; 64% of untreated children still had PS and 36% worsened. Of the children with OSA, 69% of treated children improved, 23% remained unchanged and 8% worsened; the 3 untreated children all improved. % N1, arousal indices, and oxygen desaturation index $\geq 4\%$ decreased, and % N2 and SpO₂ nadir increased in the treated group at follow-up (p < 0.05 for all).

Conclusion: Preliminary data suggests that treatment is effective in the long term in reducing OSA severity and improving sleep quality in preschool aged children. Given that PS and Mild OSA did not resolve over 3 years, further longitudinal studies are required to elucidate the long-term natural history of OSA from the preschool age.

0941

CPAP THERAPY ADHERENCE IN CHILDREN WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Many children receive their first hands-on introduction to continuous positive airway pressure (CPAP) therapy on the night of the in-lab titration. The experience in the sleep lab may influence 90-day adherence to PAP therapy. We hypothesize children with positive mask fittings and pre-trials prior to lights-out on a polysomnogram will show improved adherence. We also hypothesize children with perceived immediate benefit following the titration (post-sleep morning questionnaire) will show improved adherence.

Methods: Retrospective chart review was performed on data from 104 children initiated on CPAP therapy in 2012. Adherence was defined as use of CPAP > 4 hours per night for $> 70\%$ of nights in a consecutive 30-day period during the first 90 days of CPAP therapy. Chi square analyses and logistic regression analysis were performed to determine associations of adherence with polysomnogram processes and patient-level attributes.

Results: Of 104 children (49 girls), 58 children achieved criteria for 90-day adherence. There were no univariate associations between adher-

ence and mask fitting/pre-trial tolerance (p = 0.599), type (split-night vs. full-night) of titration (p = 0.323), baseline apnea-hypopnea index (AHI) on polysomnogram (p = 0.07), gender (p = 0.471), age (p = 0.872), or body mass index (p = 0.067). In comparison to others, patients who perceived the titration to be a 'worse' night of sleep had lower rates of adherence (p = 0.006). The logistic regression model revealed that patients who reported a 'worse' than usual night of sleep were about 80% less likely (OR = 0.195, 95%CI: 0.042-0.903) to achieve 90-day adherence when controlling for insurance status (Medicaid vs. commercial), age, and AHI.

Conclusion: Children who had subjectively poor experiences during the in-lab titration had lower 90-day CPAP adherence rates. These factors may help to identify children who require additional clinical interventions to achieve optimal adherence.

0942

NASAL DISUSE AND PERSISTENCE OF SLEEP-DISORDERED BREATHING (SDB) DURING SLEEP POST-ADENOTONSILLECTOMY IN CHILDREN

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Introduction: Adenotonsillectomy (T&A) does not eliminate abnormal breathing, and recurrences of SDB are noted at follow-up. Hypothesis: There is persistence of nasal disuse with negative impact on cranial facial growth.

Methods: 1) Retrospective study; 2) Non-obese and non-syndromic pre-pubertal children 4 to 8 years of age with SDB, treated with T&A and with pre and post polysomnogram (PSG); 3) Systematic investigation of mouth breathing during pre and post (at least + 60 days) PSG; 4) Subgroup of children (n = 9) seen early referred to myofunctional re-education (minimum opportunity: 4 months); 5) Follow-up of subgroup at + 6 months.

Results: Fifty-one children with symptoms of SDB, and PSG results mean AHI of 8 ± 2.3 event/hour mean time spent in flow limitation: $67 \pm 11\%$, presence of mouth breathing $> 25\%$ of TST = 100%. Post T&A, clinical improvement: 100%, mean AHI was 3.2 ± 1.3 , flow limitation was $45 \pm 14\%$ TST mouth breathing $> 25\%$ TST = 45 children. Myofunctional therapy referral: n = 9, Compliant n = 4 (A). No difference in age, socio-economics, post-T&A AHI, percentage of flow limitation and % mouth breathing between 2 subgroups (A, B). Results: subgroup A: AHI < 1 , flow limitation $< 20\%$ of TST time spent with mouth breathing $< 3\%$, Subgroup B (n = 5): AHI no significant (or decrease) from post T&A, flow limitation mean increase $7 \pm 3.8\%$, mouth breathing $> 7 \pm 3\%$

Conclusion: Mouth breathing during sleep is very common post-T&A. Absence of addressing the problem leads to increase in flow limitation in an untreated subgroup at + 6 months. Myofunctional therapy may eliminate mouth breathing and SDB recurrence.

0943

SLEEP VARIABILITY AND CARDIAC AUTONOMIC MODULATION IN ADOLESCENTS: THE PENN STATE CHILD COHORT

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Introduction: The association between habitual sleep patterns and cardiac autonomic modulation (CAM) in adolescents is not fully under-

stood. We investigated such association in the population-based Penn State Child Cohort (PSCC) follow-up examination.

Methods: An actigraph (GT3X) and a sleep diary were used in 421 adolescents for 7 consecutive nights to calculate nightly sleep time and sleep efficiency. We calculated within-subject 7-night means and the standard deviations (SDs). The means being used as the individual's habitual sleep duration and efficiency. The SDs were used as the individual's habitual variability of sleep duration and efficiency. CAM was assessed by heart rate variability (HRV) analysis of beat-to-beat normal R-R intervals from a 39-hour high resolution Holter ECG. The HRV indices in frequency domain [high frequency power (HF), low frequency power (LF), and LF/HF ratio] and time domain [standard deviation of normal RR intervals (SDNN), and the square root of the mean squared difference of successive normal RR intervals (RMSSD), and heart rate (HR)] were calculated on a 30-minute basis (78 repeated measures). Mixed-effects models were used to assess the relationships between habitual sleep variables and HRV relationships.

Results: The mean (SD) age was 16.7 y (2.3), with 52% male and 78% white. The mean (SD) of habitual sleep duration and its variability were 7.00 h (0.83) and 1.16 h (0.58), respectively. The mean (SD) of habitual sleep efficiency and its variability were 82% (6.2) and 7.0% (4.3), respectively. Higher sleep-duration-variability, but not mean sleep duration, was associated with lower HRV (all $p < 0.05$). Similarly, higher sleep-efficiency-variability, but not mean sleep efficiency, was significantly associated with lower HRV (all $p < 0.05$).

Conclusion: In adolescents, higher habitual sleep-duration-variability and higher sleep-efficiency-variability are associated with lower HRV, indicative of impaired CAM towards sympathetic overflow and reduced parasympathetic modulation. Habitual night-to-night sleep variability is a novel risk factor associated with cardiovascular morbidity.

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0944

COMPARISON OF LABORATORY POLYSOMNOGRAPHY AND AT HOME AMBULATORY MONITORING IN THE DIAGNOSIS OF PEDIATRIC OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) syndrome affects 1-5% of pediatric patients. Parents frequently report symptoms of OSA including snoring, pauses, disturbed sleep, and neurobehavioral problems. Untreated pediatric OSA is associated with significant morbidity such as neurocognitive impairment, behavioral problems, hypertension, and cardiac dysfunction. Diagnosis of OSA in children by history and physical exam lacks sensitivity and specificity. Laboratory polysomnography (PSG) leads to patient inconvenience, is expensive, and isn't always readily available due to a shortage of pediatric trained polysomnographers. These issues contribute to 90% of children undergoing adenotonsillectomy without confirmatory diagnostic testing. Ambulatory PSG for the evaluation of OSA may alleviate some of these barriers. There is a paucity of knowledge regarding ambulatory monitoring for the evaluation of OSA. Our study aims to investigate the use of commercial ambulatory monitoring for the diagnosis of pediatric OSA. It will look at the feasibility and validity of home devices in the pediatric population when compared to the gold standard, in-lab PSG.

Methods: This is a prospective, case-controlled study of children, ages 2-17, referred to sleep medicine due to the clinical suspicion of OSA. Subjects who meet inclusion criteria complete an in-lab PSG, in conjunction with ambulatory monitoring. The subjects then undergo home monitoring on two subsequent nights. The results of the studies are

compared for consistency, reproducibility, and diagnostic significance for OSA.

Results: Statistical analysis of 6 patients (goal of 40), revealed that there was no significant difference between apnea-hypopnea index and lowest oxygen saturation values on laboratory PSG versus ambulatory monitoring, both in-lab and at home (p values > 0.05). The study is currently ongoing.

Conclusion: Obstructive sleep apnea is common in pediatrics. The current gold standard for diagnosis leads to inconvenience, high expense, and is not readily available. Home ambulatory monitoring, an alternative diagnostic method, may alleviate these issues, thus decreasing the number of children proceeding to adenotonsillectomy without an accurate diagnosis.

0945

PEDIATRIC PAP THERAPY USE SUBSEQUENT TO A PAP-NAP PROCEDURE

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Introduction: Some research on PAP therapy use by pediatric SDB patients shows low adherence rates. This study investigated whether the PAP-NAP, an evidence-based procedure for introduction of PAP therapy to high anxiety adult patients, would be beneficial in a pediatric SDB population.

Methods: Standard protocol at Maimonides Sleep Arts and Sciences requires all pediatric patients diagnosed with SDB and needing PAP therapy complete our daytime desensitization procedure (PAP-NAP) to address psychiatric conditions, parental concerns, and general patient anxieties and fears. The PAP-NAP is a Sleep Dynamic Therapy framework procedure involving a 60-120 minute nap, during which pressures are adjusted for presumptive SDB events. Data were collected for 25 pediatric SDB patients [mean (SD) AHI = 14.2 (19.42); RDI = 39.31 (26.96)] who completed a PAP-NAP. Presumptive sleep during the PAP-NAP was determined by subjective report or decreased heart-rate observed by technician. Current PAP therapy use was determined from objective data downloads or subjective report collected during most recent follow-up.

Results: The 25 patients comprised two groups based on current PAP therapy use: Users ($n = 14$) and Non-Users ($n = 11$). Prior to PAP-NAP, users had significantly higher diagnostic PSG sleep efficiency [mean (SD) = 93.46 (4.14)% vs. 88.87 (6.07)%; $p = .04$], shorter sleep onset latency (min) [9.19 (9.14) vs 31.28 (28.53); $p = .01$], and a trend for both lower RERA index [18.51 (12.03) vs. 29.7 (16.00); $p = .07$] and age [mean (SD) = 8.63 (3.01) vs. 11.46 (4.31); $p = .07$] than Non-Users. All 14 Users (100%) achieved sleep during the PAP-NAP compared to only 72.7% of Non-Users ($p = .07$). Data downloads for Users show a compliance rate (use > 4 hours for $> 70\%$ of the week) of 84.66 (12.78)%.

Conclusion: Better sleep quality and less severe upper airway resistance during diagnostic PSG, as well as presumptive sleep during the PAP-NAP and younger age were associated with greater PAP use. Future research and controlled studies are needed on strategies such as the PAP-NAP, aimed to improve adherence rates in pediatric patients.

0946

ASSOCIATION BETWEEN THE MALLAMPATI AND BRODSKI INDEXES AND SLEEP DISORDERED BREATHING IN CHILDREN

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Introduction: The aim of this study was to investigate the association between sleep disordered breathing (SDB) and the Mallampati index (MI) and the Brodsky index (BI), which evaluate the degree of oropharyngeal obstruction.

Methods: We studied 1198 children aged 7 to 9 years from municipal schools in Osasco. The children were selected through randomization. Written informed consent was obtained from the parents or guardians of all children. We excluded children with developmental syndromes, cleft lip and/or palate, those who had undergone tonsil and/or adenoid surgery, and those who were under or had a history of orthodontic or functional jaw orthopedic treatment. The SDB was measured by the sleep disturbance scale for children (SDSC). The children were classified according to the IB and IM, ranging from 1 to 4. We initially analyzed the BI and MI separately and then simultaneously (MBI). The cutoff point used for the BI and MI was 3 or 4, which was considered a point of obstruction. For the simultaneous analysis of BI and MI, a score of 3 or 4 in IB and IM simultaneously was considered abnormal.

Results: Of the 1198 children, 216 (18.03%) had SDB, 463 (38.64 %) had MI of 3 or 4, 664 (55.3%) had BI of 3 or 4, and 275 (22.07%) had MBI of 3 or 4. Of SDB children 67% had BI of 3 or 4 compared to 53% of non-SDB children ($p < 0.001$); 42% of SDB children had MI of 3 or 4 compared to 38% of non-SDB children ($p = 0.31$), and 58% of SDB children had a MBI of 3 or 4 compared to 41% of non-SDB children ($p < 0.01$).

Conclusion: There is an association between the BI and SDB and also between the MBI and SDB.

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0947

EVALUATION OF RISK FACTORS FOR SLEEP APNEA IN CHILDREN AND ADOLESCENTS WITH BIPOLAR DISORDER

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Introduction: There is little published data on the evaluation of obstructive sleep apnea (OSA) in children and adolescents with bipolar disorder (BPD). Prior studies have suggested an increased prevalence of OSA among adults with BPD. Children with OSA often present with behavioral difficulties including mood lability, depression and poor school performance. Pediatric patients with BPD have similar difficulties. Weight gain is a common side effect of the medications used to treat BPD and a major risk factor for developing OSA. We hypothesize that snoring, increased BMI and reduced sleep efficiency presenting as insomnia may predict the presence of OSA among children with BPD.

Methods: Our study is a single center retrospective chart review of children and adolescents with BPD that were referred for a polysomnogram (PSG). There were 263 patients identified with BPD after a query of the PSG database. Of these patients, the diagnosis of BPD was independently verified using DSM-IV criteria for 27 patients (10%). Demographic, medical and PSG information were collected and analyzed.

Results: The median age of the total group was 13 years. Among the 27 patients included in our study, 6 patients had OSA (prevalence 22%) with a median AHI of 7.5 events per hour of sleep. Variables that had significant difference between the OSA and non-OSA groups were: median BMI (47 vs 30, $p = 0.001$); sleep efficiency (78.2% vs 91%, $p = 0.009$); and oxygen nadir (82% vs 92%, $p = 0.000$). There was no difference found in snoring percentage on PSG.

Conclusion: Our data suggests extreme obesity (BMI > 40), desaturation during sleep and frequent nocturnal awakenings are associated with OSA among children and adolescents with BPD. Snoring was a poor predictor of the presence of OSA.

0948

THE NATURAL HISTORY OF PRIMARY SNORING IN CHILDREN

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Introduction: Primary snoring (PS), i.e., snoring with no evidence of apneas, gas exchange abnormalities or sleep fragmentation is prevalent in children and occurs in up to 27% of children. No therapeutic intervention is currently recommended for PS, and only a few studies have investigated the natural history and consequences of this condition. Our objective was to investigate the natural history of PS in children and potential sequelae.

Methods: All children who were diagnosed with PS (AHI < 1.5) between 2006 and 2008 at our institute were included. Children with congenital anomalies, developmental delay, and chronic medical conditions were excluded. Telephone interviews were conducted 5-6 years following diagnosis and included the Pediatric Sleep Questionnaire (PSQ) scale, demographics, anthropometric measures, and information about surgical procedures.

Results: 398 children fulfilled the inclusion criteria. Of those, 248 (57% males) were included in the study. The mean age at diagnosis was 5.4 ± 3.4 years and the mean BMI z score was -0.66 ± 1.9 . Twenty percent were obese and 33% had positive family history for sleep disordered breathing (SDB). Sixty-four (26%) of the children underwent surgical procedures following the PSG evaluation. Of those, 37 (58%) had adenoidectomy, 17 (26%) adenotonsillectomy, and 10 (16%) adenoidectomy/adenotonsillectomy and tube insertion. Of the 184 children with no surgical intervention, 60 parents (33%) reported of snoring, 62 (34%) had positive PSQ score, 100 (54%) had a positive score on the inattention/hyperactive behavior subscale, and 63 (34%) had a positive score on the sleepiness subscale.

Conclusion: Despite PSG based diagnosis of PS, a considerable proportion of children still undergo surgical intervention. With no surgical intervention, a significant proportion of children continue to snore years following diagnosis and almost half of them exhibit attention deficits and hyperactive behavior.

0949

SLEEP OUTCOMES AND AIRFLOW IN ROBIN SEQUENCE (SOAR): RESULTS OF A PILOT STUDY

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Introduction: While little is known about outcomes in infants with obstructive sleep apnea (OSA), their rapid development and longer sleep needs may make them more vulnerable to its detrimental effects. Craniofacial anomalies, such as Robin sequence (RS: triad of micrognathia,

glossoptosis and cleft palate), are a common cause of OSA in infants. We hypothesize that infants with RS have higher obstructive apnea hypopnea indices (OAH), consistent with more severe OSA, compared to healthy infants.

Methods: In this prospective pilot study, we recruited 5 infants (3-6 months) with isolated RS and 5 typically developing controls. In a single overnight study visit, we collected demographic and anthropometric data, facial measurements, 3-dimensional photos, parent-report measures of sleep and behavior, developmental assessment (Bayley-III), and polysomnogram.

Results: The mean age was similar in the RS and control groups (5.3 and 5.6 months). Parents of 80% of infants with RS (vs 20% of controls) categorized their child's sleep as "problematic." On objective testing, infants with RS, when compared with controls, had 1) more severe OSA measured by OAH (16 vs. 2 events/hour); 2) lower total sleep times (463 minutes vs. 550 minutes); 3) larger hypoxic burden measured by nadir oxygen saturation (70% vs. 86%) and desaturation index (23 vs. 6 desaturations/hour); 4) lower mean cognitive scores (51st % vs. 78th %); and 5) lower mean language scores (27th % vs. 46th %). We will present statistical comparisons and correlations.

Conclusion: These data suggest that infants with RS are at risk of OSA and the associated neurodevelopmental sequelae. A larger longitudinal cohort study investigating links between sleep and neurodevelopment in RS is warranted in order to identify infants at highest risk. Developing and directing interventions for this group may ultimately help to improve the care we provide to all infants with OSA.

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0950

PEDIATRIC ADHERENCE TO POSITIVE AIRWAY PRESSURE THERAPY DURING RESEARCH AND UPON TRANSITION TO ROUTINE CARE: RESULTS OF A QUALITY IMPROVEMENT PROJECT

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Introduction: Positive airway pressure (PAP) is frequently used to treat children with OSA, yet, in research that evaluates pediatric adherence to PAP, drop-out rate is often high and adherence is often low. Once a study has ended, there are no evaluations of patterns of routine care and compliance once a research study has ended. As a quality improvement project, we aimed to evaluate patient show rate and compliance upon transitioning to routine care after participation in a larger study investigating outcomes of treatment with PAP. We analyzed clinical data for 16 participants that completed the 3-month study and were subsequently transitioned into routine care in PAP clinic 3 months after completing the study.

Methods: We evaluated patient show rate and adherence in 16 participants treated with PAP between ages 8 and 16 (mean age 11.5, mean BMI 35.4, mean AHI 18.3) during a research study and again once in routine care.

Results: At study completion, average percent usage was 77.87, average compliance of > 4 hours was 60.3 percent. 63 percent of the sample were adherent upon completion. Significant improvements in OSA symptoms were reported using the OSA-18 ($p < .001$) Total score and all indices ($p < .05$ to $p < .001$). However, only 4 children showed for the 3 month clinic visit. 4 families called to reschedule at a later date. Show

rate was unrelated to AHI but all 4 were adherent with PAP at both study end and remained so at clinic visit. 8 families (50%) missed the appointment, thus no adherence data was available.

Conclusion: Reports of improved adherence upon participation in research exist, yet other reports of decreased adherence upon completion of studies that involved frequent contact and/or participant incentives. Results of our quality improvement cycle identify need for improved transition to routine care and interventions aimed to continue adherence with appointments and PAP use once a study protocol ends.

0951

CHANGES IN OBSTRUCTIVE SLEEP APNEA OVER THE FIRST YEAR OF LIFE IN INFANTS WITH CLEFT PALATE

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Introduction: Isolated cleft palate (ICP) and craniofacial disorders resulting in tongue-based airway obstruction (TBAO) are thought to be risk factors for obstructive sleep apnea syndrome (OSAS). Changes in sleep-disordered breathing over the first year of life in these patients are unknown. We hypothesized that the apnea hypopnea index (AHI) would be greater in patients with either ICP or TBAO compared with controls and that OSAS would be persistent throughout the first year of life in ICP and TBAO except in patients with TBAO who had surgical correction with mandibular distraction osteogenesis (MDO).

Methods: Infants with ICP and TBAO underwent polysomnography (PSG) and lateral neck radiograph for cephalometrics at baseline and six-month endpoint visit. Controls underwent PSG at baseline. Endpoint visits were completed before palatoplasty in subjects with ICP or TBAO.

Results: 17 patients with ICP, 17 with TBAO, and 10 controls were recruited. Endpoint data are available for 9 subjects with ICP and 7 with TBAO. At baseline, AHI was significantly greater in TBAO (median = 26.5, range = 0.8-54.7) than controls (3.3, 0.5-23.3) ($p < 0.001$), but was not different between controls and ICP (3.2, 0.3-30.7). There was a significant reduction in AHI from baseline to endpoint spontaneously in ICP (1.2, 0.2-4.6, $p = 0.022$) and following MDO surgery in 5 of 7 with TBAO (2.8, 1.2-38.5, $p = 0.026$). In subjects with TBAO, including those who had surgery, mandibular length/body length ratio increased from baseline to endpoint ($p = 0.004$).

Conclusion: Infants, including healthy controls, have a greater AHI than previously reported using older technology. TBAO, but not ICP, is a risk factor for increased AHI during infancy. AHI decreases over the first year of life in children with ICP without intervention. Surgically increasing mandibular length is associated with reduced OSAS in children with TBAO. More research is needed to determine long-term outcomes in children with cleft palate and TBAO.

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0952

PREVALENCE OF ASTHMA AMONG CHILDREN WITH OBSTRUCTIVE SLEEP APNOEA

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Introduction: Subjective associations between asthma and obstructive sleep apnoea (OSA) have previously been shown. First-line treatment for uncomplicated OSA can improve asthma symptoms in those affected. To further understand these associations, alternatives to polysomnographically-defined OSA may be needed. Aim: To evaluate asthma prevalence in a UK clinical population referred for sleep studies.

Hypotheses: 1) asthma is more common among children with OSA; 2) asthma prevalence is associated with OSA severity.

Methods: This study includes a retrospective study of 379 children and a prospective cohort of 233 children (aged 4-16) who underwent either cardiorespiratory sleep study (CRSS) or full polysomnography (PSG) for evaluation of sleep-disordered breathing. Families were asked to complete a validated asthma symptom questionnaire. Prevalence of "lifetime" asthma and "current" asthma was compared to published prevalence in UK children (NHS Health Survey for England, 2010).

Results: The retrospective study yielded 83 responses and 233 prospective subjects were recruited (total n = 316). The total sample reported a significantly higher prevalence of lifetime asthma (19.9%) and current asthma (34.5%) than in the reference population (14.5% and 9.5%, respectively). In subjects with OSA (n = 196), the prevalence of current asthma (33.7%) was significantly higher than the reference population but this was not true for lifetime asthma (17.9%). In subjects without OSA (n = 119), the lifetime asthma prevalence (23.5%) and current asthma prevalence (36.1%) was significantly higher than the reference population. Among children with severe OSA (n = 47), there was not a significantly higher prevalence of asthma of any kind (lifetime = 6.4%; current = 34.0%).

Conclusion: Asthma prevalence among children referred for investigation of sleep-disordered breathing is significantly higher than in the general population. Asthma prevalence, however, is not associated with polysomnographically-defined OSA, regardless of severity. On-going investigations in our laboratory are assessing alternative methods to better measure sleep and breathing in children with asthma.

0953

THE PREVALENCE OF SLEEP DISORDERED BREATHING IN A PEDIATRIC COHORT WITH CHRONIC RENAL DISEASE

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Introduction: Sleep apnea has been shown to have adverse effects on vascular health, neurocognition and behavior. There is an increased prevalence of sleep disordered breathing (SDB) in adults and children with chronic renal disease (CRD). Questionnaire data alone is available for the pediatric population. SDB could have serious implications on morbidity, mortality and quality of life in CRD.

Methods: Patients with stage 3 or 4 CRD were recruited from the nephrology program at the Hospital for Sick Children. Data collection included: demographic data, clinical history, an in hospital polysomnogram (PSG), pediatric sleep questionnaire (PSQ), modified Epworth sleepiness scale, restless leg syndrome screen, the presence of attention deficit hyperactivity disorder (DSM IV criteria), and pediatric quality of life questionnaire (Peds QL). PSGs were conducted and scored according to American Academy of Sleep Medicine guidelines

Results: Data collection is ongoing; 17 CRD patients (5 on dialysis) have undergone PSG (7 females and 10 males), and PSQ. The median age was 12.5 years (0.67-17.28 years). 59% of patients had an abnormal PSG, compared to 35.3% of patients who had PSQ scores suggestive of SDB (score of > 0.33). The median (IQR range) values were: obstructive apnea/hypopnea index (AHI) 0.8/hr (0.15-3.65/hr), central apnea index 0.5/hr (0.2-1.9/hr) and combined apnea index was 3.65/hr (0.5-4.6/hr). 4 patients had clinically significant SDB (AHI > 5 or CO₂ > 50 mmHg for 25% of the night).

Conclusion: To our knowledge, there are no pediatric studies using PSG for SDB in CRD. Apart from demonstrating increased prevalence

of SDB, we were able to define the type and severity of SDB, which is of paramount importance in subsequent management. We found a discrepancy between the number of patients identified by PSQ and PSG, suggesting that PSQ alone for identification of SDB in CRD patients may not be sufficient.

0954

EFFECTIVENESS OF AN INTENSIVE CPAP ADHERENCE PROGRAM IN CHILDREN

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Introduction: Positive airway pressure (PAP) is commonly used in children to treat obstructive sleep disordered breathing (OSDB). While an effective treatment, adherence to PAP use is often poor. Utilization of a formalized adherence program (AP) may increase PAP adherence. Objectives of this study were to identify outcomes of an AP, to determine what factors affect successful PAP adherence, and to identify the commonly used interventions that increase adherence.

Methods: In our sleep center, patients with OSDB requiring PAP that consent to follow as per requirement of the program are enrolled in the AP. During the AP visits, patients are seen in the clinic by a psychologist and a respiratory therapist on a rigorous schedule. If the patient remains compliant (> 70% nights usage for > 4 hours/night) throughout the program, he/she is graduated from the program. Retrospective data included demographics, adherence and interventions at each visit, and graduation status, and was collected from the clinical database. We are presenting data on a subset; data extraction is in process.

Results: Sixty patients were included in analysis. A large portion of patients were obese (56%). Patients were classified as successful if they graduated the AP or if their adherence was optimal at a six month follow up visit. 55% (33) were successfully adherent to PAP. The median number of visits was 9 for graduated patients and 5 for those that did not graduate (p < 0.004). The overall, most common interventions recommended to patients at the visits was a plan to earn privileges for wearing PAP and a daytime desensitization plan.

Conclusion: Historically, CPAP adherence in children has been relatively poor. An AP with compliance monitoring and behavioral modifications may help to increase adherence to PAP in children.

0955

SLEEP DISORDERED BREATHING IN PEDIATRIC PATIENTS WITH A FUNCTIONALLY SINGLE VENTRICLE

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Introduction: Patients with a functionally single ventricle have reduced cardiac output and pulmonary congestion. Studies in adults suggest that heart failure is associated with an increased risk of obstructive and/or central sleep apnea. Given the paucity of such data in the pediatric population, the aim of this study was to evaluate sleep disordered breathing (SDB) in children with underlying congenital heart disease, specifically those with a functionally single ventricle.

Methods: Children with a functionally single ventricle who had a polysomnogram (PSG) at our institution were identified from a sleep database. PSG's that were performed from 2000-2013 were included. Detailed data regarding patient demographics, comorbidities, sleep symptoms and PSG results were retrospectively collected from patient's health records.

Results: Fourteen children were identified, 2 were excluded because they had trisomy 21 and 1 was excluded because there was insufficient data available. Eleven children were included, 8 male and 3 female. Sleep symptoms were reported in 3/11 children prior to PSG. Age range at the time of PSG was 2 months to 16 years. Of the included subjects, 9/11 (82%) had a diagnosis of SDB. The most common diagnosis was obstructive sleep apnea (OSA) in 6/11 children, followed by central sleep apnea (CSA) in 3/11 children and nocturnal hypoventilation in 2/11 children. Two patients had both OSA and CSA.

Conclusion: SDB was very common in this highly selected group of children. Clinicians need to be aware of co-existing sleep disorders as they may further contribute to morbidity in children with a functionally single ventricle. Future research is required to further evaluate and describe SDB in children with underlying congenital heart disease.

0956

THE EFFECT OF CERVICO-MEDULLARY DECOMPRESSION SURGERY ON SLEEP DISORDERED BREATHING (SDB) IN INFANTS WITH ACHONDROPLASIA

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Introduction: Infants with achondroplasia are more likely to have SDB due to cervico-medullary compression. Our previous study has shown increased respiratory events and attenuation of arousal response in infants with achondroplasia. Cervico-medullary decompression (CMD) surgery is indicated in patients with significant SDB, narrow foramen magnum and neurological compromise. However, there is limited information on the effect of CMD surgery on respiratory events and arousals in this population.

Methods: This is a retrospective chart review of infants with achondroplasia who underwent CMD surgery during the first year of life. Only infants with pre- and postoperative PSG were included. Paired t-test was used to assess the difference between pre- and postoperative PSG parameters.

Results: Over a 12 year period, 14 infants with achondroplasia underwent CMD surgery, and 8 patients (6 female) had a pre- and post-operative PSG. The mean age of CMD surgery was 3.9 ± 2.0 months. The mean age for the pre- and post-operative PSG was 2.3 ± 1.9 and 6.4 ± 2.2 months respectively. Compared to preoperative PSG, there was a significant decrease in obstructive index (12.8 ± 6.8 vs. 3.0 ± 1.9 /hr, $p = 0.002$), and respiratory disturbance index (16.4 ± 7.3 vs. 6.1 ± 3.9 /hr, $p = 0.004$) after surgery. There was a non-significant difference in the average end-tidal CO_2 (33.9 ± 6.1 vs. 34.3 ± 6.5 mmHg, $p = \text{NS}$). Sleep data showed a non-significant difference in arousal index (18.1 ± 5.1 vs. 16.1 ± 4.8 /hr, $p = \text{NS}$), sleep efficiency, or percentage of REM and NREM stages.

Conclusion: In addition to central sleep apnea, obstructive respiratory events are common in infants with achondroplasia who underwent surgical decompression. CMD surgery leads to a significant improvement in sleep-related respiratory events; however, there is no significant change in sleep parameters or arousal index. The mechanism underlying obstructive SDB in infants with achondroplasia is likely to be centrally mediated as it is improved with surgical decompression. Further study is needed to evaluate arousal response in these infants after surgical intervention.

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0957

CHARACTERIZING SLEEP PHENOTYPES IN OVERWEIGHT ADOLESCENTS WHO SNORE

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Introduction: Obesity is a risk factor for obstructive sleep apnea (OSA) and both disorders increase the risk for significant co-morbidities. Our group and others have shown that sleep fragmentation and sleep related hypoxemia and not OSA per se are related to abnormal glucose homeostasis in obese adolescents. Traditional interpretation of polysomnograms (PSG) may not identify the full spectrum of clinically relevant abnormalities. Thus, we sought to further characterize the frequency of sleep disordered breathing phenotypes in otherwise healthy overweight children who snore.

Methods: Overnight PSG were performed in overweight otherwise healthy pediatric subjects 10- 21 years old with a BMI > 85% with a history of snoring irrespective of other sleep related symptoms or complaints. Studies were scored using the AASM pediatric scoring guidelines. Sleep phenotypes were identified among the subjects studied. Subjects with OAH > 5 was used to define subjects with OSA. The remaining individuals were further classified into the following four categories: Hypoventilation/Hypoxemia: greater than 25% of sleep with $\text{PetCO}_2 > 50$ torr and/or baseline $\text{SpO}_2 < 95\%$; Central Apnea: CAI > 5 ; High Arousal: arousal index > 10 . Subjects who did not meet criteria for the above phenotypes were categorized as Primary Snorers.

Results: 69 PSG were evaluated (mean subject age = 13.7 ± 2.2 years, 66% male, 96% Hispanic). Average BMI of subjects was 34 ± 7.5 kg/m². Sleep phenotype distribution was 26% OSA, 19% Hypoventilation/Hypoxemia, 1% Central Apnea, 14% High Arousal, and 39% Primary Snorers. Sex, age or BMI did not predict sleep phenotype.

Conclusion: Obese adolescents and children who snore are at high risk for sleep related breathing disorders. Traditional classification of OSA may not identify all clinically relevant abnormalities. We speculate that underlying anatomic and respiratory control physiology underlie these different phenotypes.

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0958

DOES THE FREQUENCY OF SLEEP-DISORDERED BREATHING IN OBESE CHILDREN WITH TYPE 2 DIABETES IS DIFFERENT FROM THAT OF OBESE CHILDREN WITHOUT DIABETES?

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Introduction: Obstructive sleep apnea (OSA) in adults is a risk factor for type 2 diabetes mellitus (T2DM). Data in children is limited. Our objectives were to assess the frequency and severity of OSA among obese children with T2DM compared to obese BMI-SDS matched non-diabetic children, and to evaluate the associations between OSA and measures of cardiometabolic risk factors in these patients.

Methods: Obese patients with T2DM and BMI-SDS matched non-diabetic subjects were recruited and underwent polysomnography, blood pressure measurements, fasting lipid profile, insulin, glucose, liver functions and CRP levels. All participants completed a questionnaire related to past and present history of OSA and treatment. Results were compared between T2DM and obese non-diabetic controls and also according to the degree of glycemic status: T2DM, impaired glucose tolerance and normal glycemic control.

Results: Eleven patients with T2DM (age 15.9 ± 3.6 years) and 30 BMI-SDS matched non-diabetic subjects (age 12.7 ± 3.0 years) were studied. Almost 50% had a history of snoring and 26% apneic episodes. 65% complained of daytime fatigue. No significant differences were found between the two groups in history of OSA and PSG measures. No difference was found in the occurrence of abnormal PSG results (apnea hypopnea index $\geq 5/\text{hr}$). Nevertheless, the severity of glycemic abnormality tended to be associated with the incidence of abnormal PSG (45.5% in T2DM, 25% in impaired glucose tolerance and 18.2% in normal glycemic control). CRP levels were related to both glycemic status and OSA severity.

Conclusion: OSA severity was not different between obese children with and without T2DM. OSA may play a minor role in the development of T2DM in children. Both OSA and glycemic control affect CRP levels. Larger cohort studies are required to confirm these findings.

0959

AMBULATORY SLEEP MONITORING IN CHILDREN

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Introduction: Overnight laboratory polysomnography is considered the gold standard for the diagnosis of obstructive sleep apnea (OSA), but unfortunately there is limited availability and restricted access to laboratory pediatric polysomnography that often results in a long wait time. To date, there are limited studies validating the accuracy and utility of home polysomnography compared to laboratory polysomnography in the pediatric population. The purpose of this study is to demonstrate that home unattended ambulatory sleep testing is accurate compared to conventional overnight laboratory polysomnography in children.

Methods: All children (4-16 years old) with suspected OSA that required a polysomnogram were invited. The participants had a 2 night evaluation. During the first night, the subject had a home ambulatory sleep test: nasal/oral airflow, chest respiratory effort channel, and heart rate/pulse oximetry. During the second night, the subject was tested with the gold standard in-hospital polysomnogram and simultaneously recorded with an ambulatory portable sleep test. All participants completed our BAM-START Questionnaire: BMI, ADHD, Mallampati score, Snoring, Tiredness, Apnea (witnessed), sleep Restlessness, Tonsillar size. A non-parametric test (Friedman's two-way analysis of variance) was utilized for statistical analysis because the data was skewed. The test was used to compare the median AHI (apnea-hypopnea index) between the three procedures. All data was analyzed with IBM SPSS software.

Results: A total of 8 patients participated in this study. The hospital polysomnogram recorded a median AHI of 4.7 (1.1-14.4). The hospital ambulatory sleep testing recorded a median AHI of 1.5 (1.0-9.0). The home ambulatory sleep testing recorded a median AHI of 1.1 (0.9-7.4). The results found that these medians were different ($p = 0.036$). A sub-analysis with pair-wise comparison was performed for all groups: Ambulatory hospital testing versus ambulatory home testing indicated no statistical difference in AHI ($p = 0.635$). Hospital polysomnogram versus hospital ambulatory testing established a significant statistical difference in AHI ($p = 0.018$). The last group, hospital polysomnogram

versus home ambulatory testing, almost reached statistical significance ($p = 0.058$).

Conclusion: In the pediatric population, the results of this study indicate that ambulatory sleep testing should not be used to diagnose obstructive sleep apnea. The results indicate that the apnea-hypopnea index was underestimated in all participants when the ambulatory sleep test was compared to the standard of care polysomnogram. Overall, the severity of OSA was miscalculated when the ambulatory sleep test was employed; including the second night, when the equipment was applied and monitored continuously by a registered polysomnographic technologist.

0960

POLYSOMNOGRAPHY FINDINGS IN CHILDREN WITH SUSPECTED RAPID-ONSET OBESITY WITH HYPOTHALAMIC DYSFUNCTION, HYPOVENTILATION AND AUTONOMIC DYSREGULATION (ROHHAD): A CANADIAN CASE SERIES STUDY

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Introduction: Excessive weight gain is the most common first symptom in suspected cases of rapid-onset obesity with hypothalamic dysfunction, hypoventilation and autonomic dysregulation (ROHHAD) and appears usually after the age of 2 years. Although rapid onset obesity is a central feature of this condition, sleep abnormalities at presentation and their evolution in ROHHAD subjects are not well documented. The aim of this case series was to review the baseline and most recent polysomnogram (PSG) in children with suspected ROHHAD syndrome.

Methods: This was a retrospective chart review of PSG data in children presenting with ROHHAD syndrome.

Results: A total of 7 children who presented with suspected ROHHAD were identified. The median age at presentation was 8.3 y (range 4.7-10.1 y). Of these, 5/7 children presented with rapid onset obesity during early childhood (median age 4.3 y) while two patients presented later on (10 y, 11 y). Baseline PSGs revealed that 4/7 subjects had obstructive sleep apnea (OSA), 2/7 had non-obstructive hypoventilation and one subject had both OSA as well as central sleep apnea. The median (range) minimum SaO₂ was 82 (67-92%), the median peak CO₂ was 51 (38-86 mmHg). One year follow up PSG data revealed that 2 subjects with mild OSA at baseline developed nocturnal hypoventilation and worsening of OSA. Currently 5/7 ROHHAD subjects are maintained on nocturnal BI-PAP. No subject tested positive for PHOX2B mutations.

Conclusion: Although nocturnal non-obstructive hypoventilation is described as a major finding in ROHHAD syndrome, this was not a common feature at presentation. Most children in our cohort presented initially with isolated OSA but did progress to nocturnal hypoventilation. This suggests the need for vigilance and regular PSG monitoring in all cases of rapid onset obesity, as ROHHAD patients may progress rapidly to cardiorespiratory collapse without appropriate intervention.

0961

IMPACT OF HYDROXYUREA IN SLEEP DISORDERED BREATHING IN CHILDREN WITH SICKLE CELL DISEASENarang I¹, Dhanju S², Amin R¹, Al-Saleh S¹, Kadman G³, Lai D⁴¹Respiratory Medicine, The Hospital for Sick Children, Toronto, ON, Canada, ²The Hospital for Sick Children, Toronto, ON, Canada,³Schneider Children's Medical Center of Israel, Petach Tikva, Israel,⁴The University of Toronto, Toronto, ON, Canada

Introduction: Hydroxyurea has been used to treat sickle-cell disease (SCD) by pharmacologically reactivating fetal hemoglobin production. There is a high prevalence of nocturnal oxygen desaturation and obstructive sleep apnea (OSA) in children with SCD and is thought to contribute to SCD morbidity. The aim of this study was to evaluate whether the use of hydroxyurea alters nocturnal gas exchange and the occurrence of obstructive sleep apnea (OSA).

Methods: This was a retrospective chart analysis of 214 pediatric patients with SCD, conducted at the Hospital for Sick Children, Toronto. The polysomnography (PSG) and haematological data of SCD patients were analyzed. Statistical analyses employed included student's T-test and Wilcoxon Test where appropriate for PSG and haematological variables.

Results: At the time of the PSG, 34/241 of the patients were receiving hydroxyurea. The mean age (range) of the patients was 9.21 years (0-17.9). OSA was diagnosed in 29% of the SCD patients taking hydroxyurea compared to 43% who were not on hydroxyurea ($p = 0.21$). The median obstructive apnea-hypopnea index score (OAH) was 0.8 events/hour in the hydroxyurea group compared with 0.95 events/hour in the no-hydroxyurea group ($p = 0.26$). The median minimum SpO₂ was 91% in the hydroxyurea group compared with 86% in the non-hydroxyurea group ($p = 0.001$). The median hemoglobin was 93.5 g/L in the hydroxyurea group compared with 89 g/L in the no-hydroxyurea group ($p = 0.19$).

Conclusion: There were no significant differences with regards to OSA frequency between the two groups. However, children with SCD on hydroxyurea medication maintained higher oxygen saturations during nocturnal obstructive events than SCD children who were not taking hydroxyurea medication.

0962

SLEEP-RELATED HYPOVENTILATION IN CHILDREN WITH CHIARI MALFORMATIONChug LE¹, Castriotta RJ¹, Kodali L¹, Mathew R¹, Holland J², Majid R¹¹Sleep Medicine, University of Texas, Health Sciences Center, Houston, TX, USA, ²Memorial Hermann Sleep Disorder Center, Houston, TX, USA

Introduction: Chiari malformation (CM) is characterized by the herniation of the cerebellum with variable extension through the foramen magnum. Control of the respiratory center and some of its afferent and efferent components is located in the craniovertebral transition area and may be altered by the aforementioned disease. Sleep disordered breathing, such as hypopneas, central and obstructive apneas have been described however, data on the prevalence of hypoventilation is lacking. The purpose of our study is to describe the prevalence of sleep-related hypoventilation in children referred to us with CM.

Methods: We performed a retrospective chart review of all patients < 18 years of age referred with a diagnosis of CM who underwent diagnostic polysomnography (PSG) between July 2004 and November 2013. Studies with poor capnography signals were excluded. Demographic and PSG characteristics were collected. Patients were designated with 'sleep-related hypoventilation' if the end-tidal CO₂ (P_{ET}CO₂) was above 50 torr for > 25%

of the total sleep time (AASM version 2.0.2). Those with an obstructive apnea-hypopnea index (AHI) > 1.5 were diagnosed with obstructive sleep apnea (OSA) and those with > 3 central apneas/hour were determined to have central sleep apnea (CSA). Patients with sleep-related hypoventilation (CM-H) were then compared to the rest of the group (CM-control).

Results: 30 patients met the inclusion criteria for review. The mean age was 8 ± 4.6 (SD) years and 63% were male. The most common complaints were loud snoring, witnessed apneas and daytime sleepiness. The mean BMI was 19.9 ± 2.2 kg/m² and the mean obstructive apnea hypopnea index (AHI) was 5.0 ± 12.1 with 43% meeting the criteria for OSA. Eight patients (27%) had sleep-related hypoventilation. There was no difference in gender or BMI between the CM-H and the CM-controls. The mean AHI in the CM-H group was 1 ± 1.5 vs. 6.3 ± 13.8 in the CM-controls, however this was not statistically significant ($p = 0.13$). OSA was found in 37% of the CM-H vs 45% of the CM-control group. Only 2 patients had CSA, both of whom were in the CM-control group.

Conclusion: Sleep-related hypoventilation appears to be common among children with CM, including those without OSA. This may be best explained by the involvement of the respiratory control centers by the malformation. This is the first time such data has been systematically reported. Sleep capnometry is hence particularly important in the assessment of children with CM.

0963

CARDIAC OUTCOMES IN CHILDREN WITH DOWN SYNDROME AND OBSTRUCTIVE SLEEP APNEA SYNDROMEKonstantinopoulou S¹, Tapia IE¹, Cielo C¹, Brian B², Cohen MS³, Pipan M³, Xanthopoulos M³, Carroll ME⁴, Bradford R⁴, Marcus CL³¹Sleep Center, University of Pennsylvania, Philadelphia, PA, USA,²Pulmonary Hypertension, University of Pennsylvania, Philadelphia, PA, USA, ³University of Pennsylvania, Philadelphia, PA, USA,⁴Children's Hospital of Philadelphia, Philadelphia, PA, USA

Introduction: Individuals with Down syndrome (DS) are at increased risk for developing pulmonary hypertension, even in the absence of congenital cardiac disease. There is controversy in regards to the etiology of this association. However, it is possible that obstructive sleep apnea syndrome (OSAS) is a contributing factor. Studies in typically developing children with suspected or proven OSAS have shown changes in left ventricular as well as right ventricular function and structure in anywhere from 37-100%. As cardiac dysfunction is a significant cause of morbidity and mortality in individuals with DS, establishing a potentially treatable exacerbating factor such as OSAS would be important. Therefore, we hypothesized that subjects with DS and OSAS will have abnormal echocardiograms (showing evidence of left and right ventricular structural and functional abnormalities).

Methods: 20 children with DS aged 8-19 years (11.6 ± 3.4 years, mean \pm SD) underwent polysomnograms and echocardiograms without sedation. Measurements were made according to the recommendations of the American Society of Echocardiography.

Results: 20 subjects with DS had mild to severe OSAS based on the obstructive apnea hypopnea index [(AHI) 5.3-80.2 events per hour]. Of those 12 subjects had underlying congenital defect (including patent ductus arteriosus, ventricular septal defect and atrioventricular canal defect). 5 out of 12 required previous heart surgery. None of the echocardiograms showed evidence of pulmonary hypertension.

Conclusion: These data show that there is no evidence of pulmonary hypertension in this cohort of children with DS and OSAS, despite the fact that children with underlying cardiac defects and children with high AHI and were included.

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0964

REGIONAL REDUCTIONS IN SLEEP SLOW-WAVE ACTIVITY IN PEDIATRIC OBSTRUCTIVE SLEEP APNEA

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Introduction: Sleep disordered breathing occurs in approximately 34% of children and ranges from primary snoring (PS) to obstructive sleep apnea (OSA). Neurobehavioral impairments are a consistent feature of OSA and are thought to result from either hypoxic insult or sleep disruption. Sleep architecture, however, has been shown to differ minimally, if at all, in children with OSA. In addition, children with PS, who do not show gas exchange abnormalities or marked sleep disruption, exhibit neurobehavioral deficits consistent with those seen in OSA, suggesting that subtle alterations in sleep quality may contribute to neurobehavioral impairment. However, the few studies that have assessed sleep quality in childhood OSA by quantifying sleep slow-wave activity (SWA) have produced conflicting results. We recently identified a regionally circumscribed deficit in sleep slow-wave activity (SWA) using high-density electroencephalography (hdEEG) in otherwise healthy adults with OSA. Here we sought to determine if a similar SWA deficit may be present in children with OSA.

Methods: To determine whether childhood OSA is associated with regional deficits in SWA, overnight hdEEG was recorded in 9 boys with a diagnosis of OSA and 9 control boys (aged 5-11). Topographic comparisons of nocturnal SWA were made between groups.

Results: A significant reduction in SWA was observed over a centroparietal region in children with OSA relative to controls, which overlaps with the regional SWA deficit identified in adults with OSA. Interestingly, when SWA was examined using only a combination of C3/C4, the central electrodes typically used in sleep analyses, SWA did not differ between groups.

Conclusion: Childhood OSA is associated with regional deficiencies in SWA, which likely impair sleep's restorative functions and adversely impact daytime function. The failure of previous analyses to detect SWA alterations in children with OSA may be due, in part, to the limited spatial resolution afforded by standard EEG technology.

0965

SLEEP PROBLEMS AND DEVELOPMENT IN PREMATURE INFANTS: A PROSPECTIVE LONGITUDINAL STUDY

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Introduction: Sleep is important for infant-developments. Studies have shown the association of pediatric sleep problems with mental and psychomotor development, and temperament. Sleep-disordered breathing (SDB) has been reported to be more prevalent in premature infants than in full-term infants. We investigated SDB and development in preterm infants.

Methods: Neonates of gestational age less than 37 weeks were enrolled. Basic obstetric and birth data were collected and participants were followed up at 6, 12, 18, and 24 months of corrected age. The assessments (1) craniofacial assessment by inspection and photo documentation of the shape of hard and soft palates, as well as the positions of tonsils and tongue base, (2) Sleep recording by Chinese Brief Infant Sleep Question-

naire (CBISQ), sleep diary, actigraphy, and night-time polysomnography, and (3) Development assessment by the Denver Developmental Screening Test – 2nd edition (DDST-II) and the Bailey-Scales of Infant Development were done at each visit. Demographic statistics and correlation measures are performed on the software PASW Statistics (SPSS) 18.

Results: Of 247 premature infants, 135 (54.9%) were boys. Mean gestational age, body weight, body height, and head circumference at birth were 30.5 ± 3.2 weeks, 1667.7 ± 590.8 grams, 40.2 ± 5.2 centimeters, and 29.1 ± 3.3 centimeters. At 6 months corrected age, 62.1% had high and narrow-arched palate, specific SDB-related problems on CBISQ are reported in 40–55%, 74.2% were with apnea-hypopnea index (AHI) > 1/hour at polysomnography, and 20–34% have developmental delays identified by DDST-II (total score being positive) or Bailey test. The follow-up data at 1, 1.5 and 2 years showed similar pattern despite some decrement.

Conclusion: The data showed that preterm infants have higher occurrence of high-and-narrow-arched palate, more sleep problems, especially SDB ones, and higher rates of developmental delays than those born full-term, at follow-up to 2 years corrected age.

0966

ARE PARASOMNIAS IN CHILDREN OF MINIMAL CLINICAL CONCERN?

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Introduction: Parasomnias have been reported to occur in 9% to 84% of children. General clinical opinion is that childhood parasomnias are not of significant concern since they are self-limiting. The aim of this study was to look at sleep architecture and subjective psychological symptoms in children with parasomnias.

Methods: A retrospective analysis was conducted of charts of children (3-18 years old) who been referred for a diagnostic overnight polysomnographic (PSG) sleep assessment at the Youthdale Child and Adolescent Sleep Centre. A subset of children had also responded to a questionnaire battery assessing symptoms of sleepiness, fatigue, alertness, depression, anxiety and hyperactivity.

Results: Of the 2142 clinic charts reviewed, 8% of children (106 girls, 59 boys) received a sleep diagnosis of primary parasomnia. Polysomnography revealed that, compared to healthy and normal children, children with parasomnias had a reduced total sleep time and sleep efficiency, and an increased sleep onset latency, arousal index and time spent awake during sleep. Sixty charts wherein the questionnaire batteries had been completed revealed that children with a diagnosis of parasomnia were subjectively more fatigued, endorsed more depressive symptoms and were less alert.

Conclusion: This study finds that parasomnias in children are not benign. The children diagnosed with parasomnia at our clinic have poorer and more fragmented sleep and are more fatigued, less alert and report having depressive symptoms. This study supports the need to diagnose and treat parasomnias in children.

0967

COGNITIVE CHARACTERISTICS OF CHILDREN WITH NARCOLEPSY*Guignard-Perret A¹, Inocente CO², Mazza S³, Bayard S⁴, Herbillon V¹, Franco P¹*

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Introduction: The objective of this study was to conduct a descriptive analysis of cognitive characteristics in children and adolescents with narcolepsy.

Methods: Clinical and electrophysiological characteristics of 39 de novo patients from the Pediatric Lyon's Reference Center for narcolepsy were collected from 2008 to 2013. Due to the high frequency of school difficulties, intellectual ability (WISC-IV, full scale, verbal comprehension index (VCI), perceptual reasoning index (PRI), processing speed index (PSI), working memory index (WMI)) was usually proposed after the diagnosis. Some of these children were already treated at this time with stimulants.

Results: The cohort included 56 children (35 boys) with a median age of 12 years (51.7% < 10 years) with EDS (100%), cataplexy (84%), hypnagogic hallucinations (44.6%), sleep paralysis (14.3%), obesity (64.3%), signs of depression (18%), 1 child was hyperactive, school difficulties (57%) and 29% repeated a year. No differences were found between the tested and non tested children for clinical and polygraphic characteristics. Fourteen tested children (35.9%) were gifted, essentially with VCI > 130. The gifted children came from high social levels ($p < 0.001$), more spontaneous arousals on PSG ($p = 0.01$) and were more often treated with stimulants (98% vs 52% ($p = 0.025$)). VCI and Full IQ scales were correlated with social levels, spontaneous arousals, presence of treatment and school achievement. PRI was correlated with REM sleep % ($r = 0.50$, $p = 0.002$), REM sleep duration ($r = 0.46$, $p = 0.004$) and the presence of cataplexy (93 ± 10.4 for NwC and 107.7 ± 13.8 for NC, $p = 0.009$). A negative correlation was found between AHOI and PRI ($r = -0.37$, $p = 0.025$), WRI ($r = -0.42$, $p = 0.015$) and PSI ($r = -0.51$, $p = 0.002$). Low processing speed index was related to school difficulties ($p = 0.02$).

Conclusion: An interesting relation between REM sleep %, abnormal REM manifestations such as cataplexy and the perceptual reasoning ability and negative influence of sleepiness and obstructive breathing on the WISC-IV results.

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0968

UNMASKED CIRCADIAN RHYTHMS IN OLDER ADULTS WITH AND WITHOUT INSOMNIA

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Introduction: Age-related changes in the circadian system are often implicated as possible reasons for the insomnia that many seniors (60 y+) experience, but few studies have compared the circadian rhythms of seniors with- and without formally defined insomnia.

Methods: After an extensive screening process which included formal sleep diagnosis and oximetry (excluding AHI > 20); 22 Older Adults with Insomnia (OAI) and 19 Older Adults with Good Sleep (OAGS) were recruited. After a 1-week diary/actigraphy evaluation, each subject attended for a ~62 h laboratory protocol. This included a baseline night, a 24.5 h unmasking protocol, a waking day and a recovery sleep. The unmasking protocol started at 0900 and included continuous Core Body Temperature (CBT) measurement, hourly salivary melatonin [reduced $n = 15, 14$] and subjective alertness (global vigor) assessments. Unmasking involved constant wakeful bedrest enforced in time isolation with meals replaced by hourly nutritional supplements in a < 15 Lux environment.

Results: CBT phase (Tmin) and amplitude (Tamp) were very similar for OAI and OAGS groups (Tmin = 04:52, 04:58; Tamp = 0.31°C, 0.29°C respectively). However, the CBT of OAI was uniformly higher than that of OAGS by 0.23°C ($p = 0.001$). There was less total measured melatonin [a measure of amplitude] in OAI than in OAGS (127 vs. 186 pg/mL, $p < 0.05$); and a non-significant trend towards more phase lability in OAI than in OAGS. Subjective alertness showed the expected decline over the vigil. When a linear trend was removed, there remained a clear circadian alertness rhythm in both OAI and OAGS groups, with troughs at 0516 and 0600 respectively, and very similar amplitudes. In the raw scores, however, OAI were less alert than OAGS at every assessment ($p = 0.001$).

Conclusion: CBT circadian rhythm parameters were similar, but OAI were consistently warmer and less alert than OAGS. Circadian melatonin profiles revealed OAI had lower melatonin rhythm amplitudes than OAGS.

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0969

ASSOCIATIONS BETWEEN QUANTITATIVE SLEEP EEG DATA AND SUBSEQUENT COGNITIVE DECLINE IN COMMUNITY-DWELLING OLDER WOMEN

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Introduction: Healthy aging is associated with changes in circadian and homeostatic sleep regulatory processes as well as a higher prevalence of sleep disorders, which in turn can accelerate the aging process and increase the risk for cognitive impairment. EEG power spectrum can provide additional information regarding memory consolidation processes compared to traditional sleep scoring. This study examined whether quantitative sleep EEG traits predict development of mild cognitive impairment (MCI) and/or incident dementia.

Methods: Participants consisted of a subgroup of women (mean age 83 yrs) from the Sleep and Cognition Study, an ancillary study to the longitudinal Study of Osteoporotic Fractures (SOF), who were free of

cognitive impairment at the time of a baseline polysomnography study (SOF Visit 8). Cases ($n = 85$) were women who developed mild MCI or dementia by objective testing at an exam 4 years after polysomnography. Controls were randomly selected from the subgroup with no MCI/Dementia ($n = 85$). Absolute power for EEG frequency bands were generated using off-line spectral analysis based on a Fast-Fourier Transform (FFT) Routine (Vitascore, TEMEC).

Results: At Visit 8, groups did not differ in age, BMI, education, comorbidities, subjective sleepiness, sleep architecture as well as respiratory disturbance, arousal and periodic limb movement indices. Differences in EEG power density during nonREM sleep were observed over a broad frequency range, with higher values in the Dementia/MCI group particularly in the alpha band (8-12 Hz; $p = 0.003$), but also in the sigma (12-15 Hz; $p = 0.04$) and theta (4-8 Hz; $p = 0.03$) bands, and for slow wave activity (0.75-4.5 Hz) during the first 2 hours of sleep ($p = 0.02$) and during hours 4 and 6 ($p = 0.01$).

Conclusion: Our study provides evidence for quantitative EEG changes, which precede the onset of cognitive decline and the diagnosis of dementia in elderly women. Whether the observed differences are functionally related to neurodegenerative changes or represent unspecific EEG alterations remains to be investigated.

Support (If Any): K23HL103850, American Board of Sleep Medicine Junior Faculty Research Award, R01AG026720.

0970

A BEHAVIORAL INTERVENTION IMPROVES SLEEP QUALITY AMONG ADULT DAY HEALTH CARE PARTICIPANTS: RESULTS OF A RANDOMIZED CONTROLLED TRIAL

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Introduction: Studies show that behavioral interventions improve sleep in older adults; however, implementation of such interventions among frail older adults in Adult Day Health Care (ADHC) has not been tested. We conducted a randomized controlled trial comparing a 4-week behavioral; "Sleep Intervention Program" (SIP: sleep compression, modified stimulus control, and sleep hygiene education) to a similarly-structured non-directive informational control (IC) program among frail older veterans attending a VA ADHC program.

Methods: 42 veterans (mean age: 77 years, 93% male) enrolled in a VA ADHC program were randomized to receive the SIP or IC programs. All completed in-person sleep and health assessments at baseline, post-treatment and 4-months follow-up that included the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), the Patient Health Questionnaire-9 (PHQ-9) depression scale, and 3 days/nights of wrist actigraphy (Actiwatch Spectrum with default settings; medium threshold). ANCOVA models were used to compare sleep outcomes at post-treatment and 4-months follow-up, with baseline values as covariates.

Results: There were no differences between SIP and IC in PSQI or ISI scores at post-treatment or 4-months follow-up; however, there were significant improvements in actigraphy sleep efficiency ($p = .040$), number of awakenings ($p = .013$) and total time awake ($p = .014$) at post-treatment. At 4-months follow-up, improvement in number of awakenings was maintained ($p = .024$), and there was a significant reduction in PHQ-9 scores ($p = .011$).

Conclusion: Older veterans in ADHC benefitted from a 4-week behavioral sleep intervention program. These improvements were not reflected in self-reported sleep questionnaires, but were observed in terms of

reduced symptoms of depression. This short-term behavioral treatment may have important benefits in improving sleep quality and reducing depression for frail older adults participating in ADHC programs.

Support (If Any): VARRD 1RX000135-01.

0971

WHY ARE PEOPLE WITH INSOMNIA SYMPTOMS RETIRING EARLIER THAN PEOPLE WITHOUT INSOMNIA SYMPTOMS? AN ANALYSIS OF THE RETIREMENT AND SLEEP TRAJECTORIES STUDY (REST)

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Introduction: Prior research has found that people with insomnia retire earlier than people without insomnia after accounting for selected potential confounding factors. We sought to characterize the associations of insomnia symptoms experienced prior to retirement from the workforce with specific reasons for retirement (e.g., retirement due to poor health). **Methods:** We analyzed data from the Retirement and Sleep Trajectories Study, a longitudinal population-based sample, initiated in 1988, of adults employed by the State of Wisconsin. We used Cox proportional hazards models to calculate rates of becoming fully retired from paid employment between study initiation and 2013. Individuals rated 7 possible reasons for retirement on a scale from not important to very important. We investigated whether baseline insomnia symptoms (difficulty falling asleep, difficulty getting back to sleep, repeated nocturnal awakenings, early morning awakenings) were associated with an increased hazard of retiring for one or more of the seven reasons (indicated by participant-endorsement of a reason as being at least somewhat important in the decision to retire). We adjusted for age, gender, education, marital status, body mass index, smoking, and comorbidities.

Results: Data from 1658 participants were examined. About 67% were retired by 2013. Insomnia symptoms were significantly associated ($p < 0.05$) with two of the three most commonly-endorsed reasons for retirement, "wanted to do other things" and "wanted to spend time with family/friends." Insomnia symptoms were most strongly and significantly ($p < 0.001$) associated with retirement due to "poor health/disability."

Conclusion: Individuals with insomnia symptoms are at increased risk of early retirement due to poor health or disability. This association was observed even after adjustment for comorbidities including cardiovascular diseases, diabetes, cancer and obstructive lung disease.

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0972

NAPPING AND MEMORY CONSOLIDATION IN YOUNGER AND OLDER ADULTS

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Introduction: Slow-wave sleep is implicated in the consolidation of episodic memories in adolescents and in college-aged adults. By contrast, older age is associated with changes in sleep (e.g., sleep fragmentation, lower slow-wave sleep), as well as poorer memory encoding and retention, thereby raising the question whether older adults effectively consolidate memories during sleep. In the current study, we investigated whether an afternoon nap, which can contain slow-wave sleep, promoted memory consolidation in younger and healthy older adults.

Methods: Healthy younger adults (ages 18-30) and cognitively-normal older adults (ages 60-80) were recruited from Emory University and the Emory Alzheimer's Disease Research Center. Participants first completed a polysomnography-recorded adaptation nap and were screened for sleep and psychiatric disorders. Forty participants returned for a second session in which they encoded 100 words at 2 pm. During encoding, participants were told to either "remember" or "forget" each word; this "item-wise directed forgetting" procedure assesses selective encoding and intentional forgetting. Participants were then randomly assigned to take a 90-minute polysomnography-recorded nap or to rest while watching television (EEG monitoring confirmed no sleeping). Following the nap or wakeful rest interval (approximately 4 pm), participants were asked to free recall all studied words.

Results: Younger adults demonstrated better sleep quality (e.g., greater slow-wave sleep) during the nap than the older adults. In the younger adults, studied words were retained better following a nap ($M = 11.3$) than a wakeful rest ($M = 7.2$) interval, $p < .05$, with a larger nap benefit for "remember" words (Mean difference = 3.0) than for "forget" words (Mean difference = 1.3). The older adults did not show a nap-related benefit for "remember" words, but a possible nap-related benefit for "forget" words (Mean difference = 2.0).

Conclusion: Nap-dependent memory consolidation may change from healthy younger to healthy older adults.

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0973

CEREBRAL OXYGENATION DURING SLEEP AND MARKERS OF INFLAMMATION/OXIDATIVE STRESS IN COMMUNITY DWELLING ELDERLY WITHOUT SLEEP APNEA: A PILOT STUDY

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Introduction: Intermittent hypoxia activates inflammatory/oxidative stress pathways, promoting the release of antioxidants and neurotrophic factors. However, peripheral measures may not correlate with brain oxygenation. This pilot study compared measures of inflammation, oxidative stress, antioxidant activity, and brain-derived neurotrophic factor in 20 older adults, with normal and marginal cerebral oxygen levels during sleep.

Methods: Subjects (5M/15F, age 70-96 years) underwent two nights of polysomnography including measures of percent regional cerebral oxyhemoglobin saturation [$rcSO_2$] by cerebral oximetry. The first night served as a habituation night, all $rcSO_2$ analyses were done with data collected on Night 2. Measures of inflammation (serum C-reactive protein [CRP]) and oxidative stress (plasma reduced-to-total glutathione ratio [GSH/GSSG]), antioxidant activity (serum glutathione peroxidase [GPX]) and serum levels of brain-derived neurotrophic factor [BDNF] were collected in the morning, following Night 2.

Results: Fourteen subjects had normal ($> 60\%$) and six had marginal ($51\%-60\%$) $rcSO_2$ during sleep; all had apnea-hypopnea indexes < 5 /hour and arterial oxyhemoglobin saturations [SAO_2] $\geq 92\%$. CRP was > 3.0 mg/dl in 42% with normal $rcSO_2$ and 83% with marginal $rcSO_2$ ($X_{2(df=1)} = 3.0$, $p = .05$). GSH/GSSG did not differ by group. Reflecting increased antioxidant activity, GPX was higher in the marginal $rcSO_2$ group ($t_{(df=18)} = 2.1$, $p = .05$). In marginals, lower $rcSO_2$ during sleep was associated with higher BDNF ($r = -.90$).

Conclusion: Lower $rcSO_2$ is associated with higher levels of inflammation and probably, the release of reactive oxygen species. Subjects

with marginal rcSO_2 during sleep are experiencing metabolic stress and rcSO_2 may be a means of evaluating risk for oxidative injury.

Support (If Any): UL1RR025747.

0974

SLEEP DISTURBANCE PREDICTS LOWER QUALITY-OF-LIFE AND GREATER DEPRESSION IN OLDER VETERANS ATTENDING ADULT DAY HEALTH CARE

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Introduction: Healthy sleep is a critical component of maintaining functional independence in frail older adults such as those participating in VA Adult Day Health Care (ADHC). Despite the positive associations between healthy sleep, daytime function, and physical rehabilitation goals, sleep is not an integral part of ADHC programming. The goal of this study is to examine whether sleep disturbance predicts quality of life and depression in frail older Veterans attending VA ADHC.

Methods: As part of a larger behavioral treatment study in VA ADHC, 72 older Veterans (mean age: 78.5 years, 94% male) completed an in-person sleep and health assessment that included the Pittsburgh Sleep Quality Index (PSQI; with 3-factor scoring), Short Form-12 Health Survey (SF-12 mental (MCS) and Physical (PCS) components), Patient Health Questionnaire-9 (PHQ-9), and Mini-Mental State Examination (MMSE). Relationships between sleep and other measures were examined with Pearson correlations. Stepwise regression models examined predictors of quality-of-life (SF-12 MCS) and depression (PHQ-9).

Results: Mean PSQI score = 6.6; 54% had PSQI > 5; mean MCS score = 49.7, mean PHQ-9 score = 5.7. Higher PSQI was associated with greater depression ($p < .001$). Lower perceived sleep quality (PSQI Factor 2) and greater daily disturbance (PSQI Factor 3) were associated with lower quality of life and greater depression (all p 's < .05). Lower perceived sleep quality was a significant predictor of quality of life ($p = .05$) and depression ($p = .002$). Age and cognitive status (MMSE) were not significant predictors in either model.

Conclusion: Findings suggest lower perceived sleep quality and greater daily disturbance is associated with lower quality-of-life and greater depression in ADHC participants. Further research is needed to examine the effect of behavioral sleep interventions on sleep quality, quality-of-life and depression in ADHC participants. Our findings suggest that treating sleep disturbance may lead to improved overall outcomes in ADHC participants.

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0975

SOCIAL INTEGRATION AND SLEEP: AN INDIRECT AND AGE-MODERATED ASSOCIATION

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Introduction: The literature examining the association between positive social constructs and sleep is burgeoning, yet research examining age-related changes in this association remains limited. Social integration represents an individual's sense of belonging within a larger community, and is one social construct that may perpetuate better sleep either directly or indirectly, through a variable such as engagement in positive events. The aims of the present analyses were to identify: the association between social integration and global sleep quality, if engagement in positive events mediates the relationship between social integration and

global sleep quality, and if the association between social integration and positive engagement is moderated by age.

Methods: The current study was an archival analysis of middle-aged ($n = 810$; $M = 50.28$) and older adults ($n = 244$; $M = 71.77$), who participated in the Midlife in the United States-II study. The Social Well-Being scale, the Positive Events Scale, and the Pittsburgh Sleep Quality Index were completed by mail.

Results: Hierarchical regression was used to test study aims. Gender and self-rated health were covariates. In the overall sample, the regression and subsequent Sobel test indicated that engagement in positive events mediated the association between social integration and global sleep quality, $z = -4.54$, $p < .001$. Further, age moderated the relationship between social integration and global sleep quality, $\beta = .15$, $p = .04$, such that greater social integration scores were associated with better sleep quality in middle-aged, relative to older, adults.

Conclusion: Age differences in the association of social integration to sleep were identified. Whereas greater engagement in positive events was beneficial across ages, the tendency for increased social integration to be uniquely associated with better sleep in middle-aged adults may be reflective of age-related shifts in social goals. The findings broadly suggest that behavioral engagement may be more influential than psychosocial perceptions in promoting healthy sleep.

0976

LONGITUDINAL CHANGES IN FUNCTIONAL OUTCOMES OF SLEEPINESS ASSOCIATED WITH WORK-RETIREMENT TRANSITIONS

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Introduction: Very little research has investigated the longitudinal association between work-retirement transitions and functional outcomes of sleepiness. With data from the Retirement and Sleep Trajectories study (REST), we investigated whether work-retirement transitions are associated with changes in functional outcomes of sleepiness up to two years post-retirement. We hypothesized that, for given levels of daytime sleepiness, retirees would experience lesser decrements in daytime functioning due to sleepiness than persons who remained employed, independent of confounding factors.

Methods: REST participants represented a random sample of adults employed by the State of Wisconsin in 1988. Three annual mailed surveys were sent to participants from 2010-2013. Surveys included questions about employment status and functional outcomes of sleepiness, measured with a modified Functional Outcomes of Sleep Questionnaire (FOSQ-10m). Lower scores indicate worse daytime functioning due to sleepiness. Partial retirement was defined as a full-time to part-time work transition; full retirement was defined as a full-time work to full retirement transition. General linear models estimated longitudinal associations between change in FOSQ-10m scores and work-retirement transitions. We evaluated FOSQ-10m score changes over both 1- and 2-year follow-up intervals. All models adjusted for age, gender, education, marital status, smoking, alcohol use, and self-reported daytime sleepiness.

Results: 1677 respondents (age 46-84 years, 52% female) provided 1-year change observations. Overall mean (SD) FOSQ-10m scores changed little from baseline (31.8 [3.7]) to 1-year follow up (31.7 [3.7]). However, participants who fully retired had improved FOSQ-10m scores relative to respondents who remained working full-time ($\beta = 1.1$, $p < 0.001$); those who partially retired also had improved FOSQ-10m scores relative to continuing full-time workers ($\beta = 0.7$, $p = 0.04$). Similar findings were observed for changes in FOSQ-10m scores over two years of follow-up.

Conclusion: For a given level of subjective sleepiness, recent retirees appeared to experience lesser decrements in daytime functioning due to sleepiness than persons who remained employed.

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0977

COMPARATIVE RISK FACTORS OF EXCESSIVE DAYTIME SLEEPINESS IN THE ELDERLY IN A LARGE-SCALE SLEEP CLINIC COHORT

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Introduction: Excessive daytime sleepiness (EDS) affects 10-30% of adults older than 65. Limited data regarding prevalence and associated risk factors of EDS in elderly compared to middle-aged adults. Age-related differences in EDS likely reflect increased comorbidities in elderly. We hypothesize that in a sleep clinic-based sample, elderly have increased EDS compared to their middle-aged counterparts and that EDS is associated with co-morbid factors. We compared patients > 65 years to middle-aged patients seen in a sleep disorders clinic.

Methods: Computerized self-report responses were linked to clinical and polysomnogram data in a cross-sectional analyses of 5,484 patients over a 4.8 year period of time. EDS was defined as Epworth Sleepiness Score (ESS) > 10. Stepwise logistic regression models included potential risk factors: age > 65, sex, apnea hypopnea index (AHI) ≥ 30, neck-height ratio, body mass index (BMI) ≥ 30 kg/m², depression (PHQ9 score) > 14, and electronic record diagnoses of selected underlying co-morbidities.

Results: There were 638 elder participants (mean age 72.0 ± 5.3 years, 246 females and 392 males) and 4,849 middle-aged participants (mean age 31.9 ± 7.2 years, 2,172 females and 2,677 males). The elderly EDS prevalence was 32.6% vs. 45.2% in middle age ($p < 10E-8$). The stepwise regression model showed the elderly had lower odds of EDS (OR 0.65, 95%CI: 0.54–0.78), after correction for being male (OR 0.83, 95%CI: 0.74–0.93), AHI ≥ 30 (OR 1.20, 95%CI: 1.04–1.38), PHQ9 > 14 (OR 2.94, 95%CI: 2.54–3.39), RLS (OR 1.26, 95%CI: 1.08–1.46), and Narcolepsy (OR 4.81, 95%CI: 3.43–6.74)

Conclusion: This study showed substantial prevalence of EDS in elderly patients seeking sleep medicine care, but only 13% less than middle age patients. However, the regression analysis suggests that elderly patients have slightly less tendency for unwanted dozing compared to middle-aged individuals, after correcting for other risk factors affecting likelihood for daytime dozing. Age-related effect may reflect either biological or psychometric differences in elderly concerning sleepiness.

0978

SLEEP DISTURBANCES AND INPATIENT HEALTH CARE UTILIZATION AMONG OLDER WOMEN

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Introduction: Sleep disturbances are common in aged populations and often associated with co-morbid medical conditions. However, little is known about the extent to which sleep disturbances impact health care utilization, especially among an unselected population of community-dwelling older adults.

Methods: 1,556 women (mean age 84.0±3.8 years) enrolled in the Study of Osteoporotic Fractures (SOF). Sleep disturbances assessed at the Year 16 exam (2002-2004) using wrist actigraphy (mean 4.2±0.7 nights) and by self-report (Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS)). Inpatient utilization obtained from Medicare MedPAR files, and subset to women who were enrolled in a Part A plan. Log-binomial regression used to assess risk of being hospitalized in the year after the clinic exam. The rate-ratio of inpatient days among women with sleep disturbance compared to those without sleep disturbance was estimated using negative binomial regression and restricted to those with ≥ 1 hospitalization(s).

Results: Sleep disturbances were prevalent (29% total sleep time (TST) < 5 hr; 13% TST > 8 hr; 10% sleep efficiency < 70%; 29.4% wake-after-sleep-onset (WASO) > 90 min; 50% PSQI > 5; and 10% ESS > 10). Thirty percent (n = 462) of the sample was hospitalized for a cumulative total median (IQR) of 5.0 (3-9) days in the hospital. In age-adjusted models, reduced sleep efficiency, prolonged sleep latency and increased WASO were each associated with a 55-66% increased relative risk of being hospitalized. Associations were attenuated to 32-63% increased relative risk, after further adjustment for health status, comorbidity burden, walking speed and IADL impairments, but remained statistically significant. Furthermore, increased WASO and PSQI > 5 were associated with 20-30% more inpatient days. Sleep duration and excessive daytime sleepiness were not associated with inpatient utilization.

Conclusion: Poor sleep efficiency, prolonged sleep latency and greater nighttime wakefulness are associated with a higher risk of hospitalization among older women. These associations are in part (but not fully) explained by a greater burden of disability, and comorbidities among those with sleep disturbances.

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0979

EARLY-LIFE TRAUMA EXPOSURE, DEPRESSION SYMPTOMS, AND SLEEP QUALITY CONTRIBUTE TO MEDICAL PROBLEMS AMONG OLDER ADULTS

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Introduction: Early-life trauma exposure negatively impacts mental and physical health trajectories into adulthood. Sleep quality is largely unexplored as an underlying mechanism within these trajectories. The study objective was to examine the contributions of early-life trauma exposure, depression, and sleep quality to medical problems among older adults.

Methods: Participants were older adults ($N = 116$; 68.01 ± 6.39 years; 64.66% female) who were diagnosed with primary insomnia ($n = 64$) or who were good sleepers ($n = 52$). Participants completed measures that assessed their early-life trauma exposure, current depression symptoms, past month sleep quality, and self-reported medical problems. Structural equation modeling was used to examine associations among early-life trauma exposure, depression, and sleep with medical problems. In this model, medical problems was a latent variable derived from fifteen individual medical history items that were grouped (i.e., parceled) into three separate indicator variables; all other observed variables were scores from individual assessments.

Results: The data fit the structural regression model ($\chi^2 = 9.84$, $df = 8$, $p = .28$; CFI = .97; RMSEA = .045) and accounted for a moderate amount of variance in medical problems ($R^2 = .24$). The following sequence of direct associations was observed: 1) Early-life trauma exposure was associated with late-life depression symptoms ($\beta = .24$, $p = .02$); 2) late-life depression symptoms were associated with past-month sleep quality ($\beta = .23$, $p = .02$); and 3) past month sleep quality was associated with medical problems ($\beta = .39$, $p < .001$). Early-life trauma exposure was also directly associated with medical problems ($\beta = .28$, $p = .01$). Neither depression symptoms nor sleep quality served as viable mediators within the model.

Conclusion: Early-life trauma exposure was moderately associated with late-life depression symptoms and medical problems. Early-life trauma was also associated with medical problems through a pathway that included late-life depression and sleep quality. These data suggest that sleep quality may be a relevant underlying mechanism involved in trajectories of wellbeing following early-life trauma exposure.

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0980

VARIABILITY IN THE DURATION OF NOCTURNAL AWAKENINGS PREDICTS TASK-DEPENDENT COGNITIVE PERFORMANCE IN CARDIAC PATIENTS WITH IMPLANTABLE CARDIOVERTER-DEFIBRILLATORS (ICDS)

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Introduction: Implantable cardioverter-defibrillators (ICDs) significantly reduce death due to arrhythmias in at-risk patients. Many ICD patients self-report negative outcomes attributed to these devices ('phantom' shocks, nighttime shocks) that are associated with anxiety

and sleep difficulties. Sleep disturbance is associated with impaired neurocognitive functioning, which has been identified in patients with ICDs and represents a potential risk factor for reduced functional independence throughout older adulthood. We aimed to examine how waketime during the night contributes to reduced cognitive performance in ICD patients.

Methods: 42 patients (age = 60.4 ± 12.3) with ICDs completed sleep diaries for 14-days and a neurocognitive testing battery. 12 hierarchical multiple regressions controlling for age and education were computed with diary-reported averages and individual standard deviations (ISDs; measures night-to-night variability) for waketime after sleep onset (WASO) serving as predictors. Dependent variables were throughput (accuracy/speed; higher scores indicate faster, more accurate performance) on a simple reaction time task, the digit symbol substitution task, congruent and incongruent trials on the Eriksen Flanker, and critical 1-back and 2-back trials of the N-back.

Results: Bonferroni corrections were used; alpha level for significance = .004. Greater mean WASO significantly predicted greater throughput on critical N-back 2-back trials ($R^2 = .29$, $b = .714$). Increased variability in WASO was the strongest predictor of throughput on the congruent Eriksen Flanker ($R^2 = .52$, $b = 1.004$) and 2-back trials ($R^2 = .55$, $b = 1.354$). Moderate relationships were observed between mean and variability in WASO and throughput on other cognitive tasks; none were significant.

Conclusion: In ICD patients, nocturnal waketime may not significantly impair cognition on simpler, less demanding tasks, while extra 'compensatory' effort may be made on difficult tasks requiring executive functions and working memory to overcome sleep-related deficits. Furthermore, increased variability in waketime may be perceived as more impairing, leading to enhanced effort. Further research on sleep and cognition in this population is needed.

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0981

QUALITY OF SLEEP AND FATIGUE IN THE ELDERLY UNDERGOING CHEMOTHERAPY

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Introduction: Old age brings greater likelihood of chronic diseases, including cancer. An important consequence of cancer is the poor quality of sleep, which is more common in the elderly. Objectives: To evaluate the relationship between sleep quality and fatigue in elderly patients with cancer diagnosis undergoing outpatient chemotherapy treatment.

Methods: Cross sectional, conducted with a non-probability sample of 140 elderly (mean age 69.8 years SD = 6.8; 52.1% female, average schooling of 4.0 years), developed at two specialized cancer services of a university hospital in Southeastern Brazil. Data used the instruments: Pittsburgh Sleep Quality Index (PSQI) and Piper Fatigue Scale-revised. Descriptive statistics; Chi-square test in order to assess the association between categories of sleep quality (good or bad) and socio-demographic and clinical data; Mann-Whitney test to compare the distribution of numerical variables according to categories of sleep quality, and distribution of sleep quality scores according to the categories of socio-demographic and clinical data. A univariate logistic regression model was fit to evaluate possible risk factors associated with sleep quality ($p \leq 0.20$ in bivariate analysis). The value of $p < 0.05$ ($\alpha = 5.0\%$) was adopted as the critical level for all tests.

Results: 62.9% of subjects had poor sleep quality and 37.1%, good-quality sleep, according to the PSQI. Overall mean scores were 7.7 (SD = 4.0), median 7.0, indicating poor sleep quality. It was observed that 30.7% of subjects reported less than six hours of night sleep. Fatigue

was reported by 42.9% of the elderly, the highest score assigned to Affective Dimension (mean 3.7, SD 4.3, median 0.0). Significant association was found between bad sleep quality and: fatigue ($p = 0.03$); pain ($p = 0.00$).

Conclusion: Study points to the relationship between fatigue, pain and poor sleep quality in cancer patients, stressing the need to evaluate and treat them as a whole.

0982

ASSOCIATIONS BETWEEN SLEEP QUALITY, DAYTIME ALERTNESS, AND PERFORMANCE ON UFOV IN OLDER AND YOUNGER ADULTS

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Introduction: The Useful Field of View (UFOV) test of visual attention is associated with driving performance in older adults. Thus, poor performance on the UFOV is predictive of crashes. One study hypothesized that limited UFOV is due to external conditions including heavy traffic, but found that an internal factor, a low state of alertness was most influential in limiting UFOV. This study explored relationships between subjective reports of sleep quality and daytime alertness and UFOV.

Methods: Older ($M = 65.5$ yrs) and younger adults ($M = 21.6$ yrs) completed the Pittsburgh Sleep Quality Index (PSQI) and a modification of it to evaluate chronic and acute sleep quality and daytime alertness. They also performed the UFOV that evaluates processing speed, divided attention, and selective attention. Correlations were computed between specific PSQI questions and UFOV scores.

Results: Sleep efficiency of 85% or greater was reported by 96% of the participants. In older and younger adults, reports of "sleepiness while driving" were correlated with slower processing speed, $r(77) = .44$, $p < .01$, and poorer divided attention $r(77) = .25$, $p < .05$. The correlation remained significant when younger adults were excluded from the analysis. In older adults, "feeling better than usual upon waking" was correlated with better selective attention, $r(35) = -.36$, $p < .05$. In younger adults, "satisfaction with last night's sleep" was correlated with processing speed, $r(42) = .39$, $p < .05$, but not divided or selective attention.

Conclusion: Findings suggest that subjective reports of sleep quality and daytime alertness are useful in that they are correlated with objective measures of visual attention. Furthermore, UFOV, a relatively simple test, appears to be sensitive to subtle changes in arousal that participants are able to report. This information should be included in driver's refresher courses for seniors. Future studies should use experimental designs to further elucidate relationships between sleep quality, daytime alertness and visual attention.

0983

PEDIATRIC SLEEP PROBLEMS ARE ASSOCIATED WITH INCREASE ODDS FOR LATE-LIFE INSOMNIA AND EARLIER DEPRESSION AND ANXIETY ONSET ACROSS THE LIFESPAN

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Introduction: The negative long-term health effects of pediatric sleep problems are gaining increased attention. Pediatric sleep problems may lead to distinct yet commonly comorbid conditions such as insomnia and mental health disorders. The association between pediatric sleep

problems with late-life sleep problems and the onset of mental health problems are unknown. The study objectives were to examine whether having experienced pediatric sleep problems is associated with: 1) increased odds for having late-life insomnia, and 2) earlier age of depression/anxiety onset across the lifespan.

Methods: Participants were older adults ($N = 116$; 68.01 ± 6.39 years; 64.66% female) who were diagnosed with insomnia ($n = 64$) or were good sleepers ($n = 52$). Participants were assessed with the Structured Clinical Interview for DSM-IV Axis I Disorders to identify primary insomnia and the age at first-onset of depression or anxiety. Participants completed a sleep survey on the presence or absence of the following sleep problems during childhood or adolescence: insomnia, sleep walking, sleep talking, bed-wetting, night terrors, nightmares, head-banging or body-rocking, seizures during sleep, daytime sleepiness, breathing difficulties, or other pediatric sleep problems. The number of endorsed items was summed to create a pediatric sleep problem score.

Results: Older adults who experienced at least one pediatric sleep problem (38.79%) were more likely to be diagnosed with late-life insomnia compared to older adults who did not experience any pediatric sleep problem ([66.67% versus 47.89%, respectively] $X^2 = 3.93$, $p = .048$; OR = 2.18, CI = 1.00-4.73). A Cox regression survival analysis indicated that among older adults, increased pediatric sleep problems was a risk factor for earlier onset of depression or anxiety ($\text{Exp}[B] = 2.57$, CI = 1.11-5.97, $p = .028$).

Conclusion: Pediatric sleep problems were associated with increased odds for having late-life insomnia and the earlier development of depression and anxiety across the lifespan. The identification and treatment of pediatric sleep problems may be central to averting developmental trajectories toward sleep and mental health problems across the lifespan.

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0984

LONGITUDINAL CHANGES IN SLEEP DURATION AND INSOMNIA SYMPTOMS ASSOCIATED WITH WORK-RETIREMENT TRANSITIONS

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Introduction: Few studies have addressed longitudinal changes in sleep duration and insomnia associated with retirement. Using data from the Retirement and Sleep Trajectories study (a collaborative project with the Wisconsin Sleep Cohort study), we investigated whether work-retirement transitions were associated with changes in sleep duration and insomnia symptoms 1 and 2 years post-retirement.

Methods: Three annual surveys that included questions about work status, sleep habits, and health were mailed to potential respondents. Linear regression was used to estimate changes in sleep duration and insomnia symptom-days per month associated with a work-status transition from full-time to part-time work or working to retired status between surveys. Subjects that responded to two consecutive annual surveys were included in the 1-year change models, taking into account correlated data from subjects who were included twice; subjects that responded to surveys 1 and 3 were included in the 2-year change models. Models were adjusted for multiple potential confounding factors.

Results: 1647 individuals provided 2964 observations for the 1-year analysis and 1601 individuals were included in the 2-year analysis (46-84 years, 48% male). Subjects who transitioned from full-time to part-time work had weeknight sleep that was a mean (95% CI) 22 (8, 35) minutes longer after 1 year and 29 (10, 48) minutes longer after 2 years.

Full-time workers who transitioned to retirement slept 24 (14, 34) and 26 (14, 39) minutes longer after 1 and 2 years, respectively. All sleep duration changes were significantly different from 0 ($p < 0.05$). Insomnia symptom-days per month did not change with retirement transition after 1 or 2 years.

Conclusion: Transitioning from full-time to part-time work or working to retired status is longitudinally associated with longer weeknight sleep duration, with a larger increase about 2 years after retirement than after one year. No significant changes in insomnia symptom-days per month were found 1 or 2 years post-retirement.

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0985

DECREASED SLEEP DISCREPANCY IS ASSOCIATED WITH AMOUNT OF IMPROVEMENT IN INSOMNIA SEVERITY FOLLOWING COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA IN OLDER ADULTS

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Introduction: Sleep discrepancy (S_{disc}), the absolute time difference between self-report and objective measures of sleep, increases with age and with insomnia diagnosis. Utilizing daily sleep diaries and actigraphy, S_{disc} can be characterized by its mean level as well as its night-to-night variability. Recent evidence suggested cognitive-behavioral therapy for insomnia (CBTI) decreases S_{disc} in older adults with insomnia (OAI). We hypothesized that CBTI will significantly reduce both mean level and variability in S_{disc} , and that the magnitude of these reductions will be associated with the magnitude of symptom improvement in OAI.

Methods: Participants included 50 OAI (60 y+ , 35F) who completed a 7 day sleep diary concurrent with actigraphy (Actiwatch-2) pre- and post-CBTI. Daily discrepancy in sleep onset latency (SOL_{disc}) and wake after sleep onset ($WASO_{disc}$) were calculated by subtracting daily actigraphy values from respective diary estimates. Each participant's mean and standard deviation (night-to-night variability) of these variables were computed pre- and post-treatment. Symptom improvements were determined by pre- to post-treatment reductions in Insomnia Severity Index (ISI) scores. Repeated measures ANOVA and hierarchical linear modeling assessed pre-post changes in S_{disc} variables and their associations with ISI changes.

Results: Treatment with CBTI resulted in significant reductions in mean level SOL_{disc} [17.84 vs. 8.59 min, $p < .01$] and $WASO_{disc}$ [17.42 vs. -5.73 min, $p < .001$]. Night-to-night variability in $WASO_{disc}$ also declined significantly [43.20 vs. 26.41 min, $p < .001$]. Individuals with greater pre- to post-treatment decline in mean level SOL_{disc} , mean level $WASO_{disc}$, or $WASO_{disc}$ variability had greater decline in pre- to post-treatment ISI score [$F_{(1,94,23)} = 5.42$, $p < .05$; $F_{(1,63,96)} = 15.29$, $p < .001$; $F_{(1,92,84)} = 14.58$, $p < .001$; respectively].

Conclusion: Results demonstrated that insomnia symptom improvements following CBTI corresponded with reduced mean level S_{disc} and $WASO_{disc}$ variability. Causal relationships remain unclear. We posit S_{disc} predisposes and perpetuates late-life insomnia and that improved S_{disc} reflects realignment of perceptual and global sleep processes.

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0986

ASSOCIATION OF NEIGHBORHOOD DISORDER WITH INSOMNIA SYMPTOMS: FINDINGS FROM THE HEALTH AND RETIREMENT STUDY

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Introduction: Some literature exists to suggest an association between neighborhood characteristics and sleep disturbances, but more research in this area is needed in nationally representative samples. We determined the association between neighborhood variables and insomnia symptoms in a nationally representative sample of adults aged 50 and over.

Methods: We studied 7,286 participants from the 2006 wave of the Health and Retirement Study. Participant-reported neighborhood variables included measures of physical disorder (vandalism and graffiti, feeling safe alone after dark, cleanliness, vacant/deserted houses or storefronts) and social cohesion (feeling a part of the area, trustworthiness, friendliness, help in time of trouble); both were on a 7-point scale, and higher scores indicated greater disorder/lower cohesion. Insomnia variables included trouble falling asleep, waking up during the night, waking too early, and feeling unrested. We considered participants to have an insomnia symptom if they reported experiencing it most of the time or sometimes. Survey weights were applied to make results nationally representative.

Results: Participants' mean \pm standard error age was 65 ± 0.2 . After adjustment for age, income, race, education, sex, chronic diseases, body mass index, depressive symptoms, smoking, and alcohol consumption, every one-unit increase in neighborhood physical disorder was associated with a 12% greater odds of trouble falling asleep (odds ratio (OR) = 1.12, 95% confidence interval (CI) 1.05, 1.19). Similarly, for every one-unit increase in lower social cohesion, there was a 7% increased odds for trouble falling asleep (OR = 1.07, 95% CI 1.01, 1.13).

Conclusion: We found that indices of greater neighborhood disorder and lower social cohesion were associated with greater odds of difficulty initiating sleep. Findings suggest that these neighborhood-level variables may affect sleep, and consequently health, in middle-aged and older adults.

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0987

ONE YEAR EVOLUTION OF SLEEP QUALITY IN CHRONIC BENZODIAZEPINE USERS COMPARED TO NONUSERS

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Introduction: Benzodiazepines and z-drugs (BZD/Zs) are the most commonly prescribed symptomatic treatment for sleep problems in Belgium. Chronic use of BZD/Zs is discouraged because of the unproven long-term effectiveness. Older persons, and more specifically nursing home residents, are large consumers of these drugs. The objective of this study performed in the nursing home setting was a) to evaluate one year evolution of subjective sleep quality in chronic BZD/Z users, b) to compare it to nonusers and c) to assess variables which were associated with a worsening of sleep quality.

Methods: All mentally competent residents from 10 Belgian nursing homes were screened and compiled in a group of chronic BZD/Z users or nonusers, based on the medication chart. We collected demographic, functional and psychometric characteristics (depressive symptoms with Geriatric Depression Scale-8), sleep parameters (with Pittsburgh Sleep Quality Index-PSQI) and medication use. We analysed evolution of sleep quality with nonparametric statistics. Associations with worsening of sleep quality were analysed with linear regression.

Results: We collected data of 131 BZD/Z users and 95 nonusers. The mean age in both groups was 85 year and 77% was female. Over a period of 1 year, in the BZD/Z group, the PSQI score evolved from 5.2 to 5.8 ($p = 0.035$) and in the nonusers from 4.3 to 4.7 ($p = 0.078$). Though the mean difference did not differ significantly between both groups ($p = 0.890$), the BZD/Z users had a significantly worse sleep quality compared to nonusers at both time points.

Depressive symptoms were significantly linked with worsening of sleep quality (GDS score $\beta = -0.247$, $p < 0.001$).

Conclusion: Chronic BZD/Z users slept worse than nonusers. Moreover, their sleep quality got significantly worse after 1 year compared to nonusers. This indicates that the continuation of chronic BZD/Z use is not favourable in terms of sleep quality. Depressive symptoms seem important in worsening of sleep quality.

0988

DO SLEEP DISTURBANCES AND BENZODIAZEPINE USE PREDICT COGNITIVE DECLINE IN OLDER ADULTS?

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Introduction: Sleep disturbances are common in the elderly and the majority of cases are treated with benzodiazepine medications. Both sleep disturbances and benzodiazepine use have acute effects on cognition. Prospective studies on sleep disturbance and its association with cognitive decline are equivocal, as are longitudinal studies of benzodiazepine use and its effects. However studies have not investigated the independent/combined effects of sleep and medication use.

Methods: N = 1,757 community-based participants aged 60-64 years from the PATH (Pathways Through Life) study were examined at baseline in 2001 and followed up in 2005 and 2009. Exposures were self-reported sleep disturbance, use of benzodiazepine medications, or both. Outcome measures were the Mini Mental State Exam (MMSE), California Verbal Learning Test, digit span, symbol digit modalities, and trail making. Fixed effects modeling adjusted for age, gender, educational level, physical and mental comorbidities, and other medication use.

Results: Small but statistically significant declines in cognition were observed over time (effect sizes ranged from $d = 0.1$ to 0.4). Preliminary analyses demonstrated no significant effects of either sleep disturbance or benzodiazepine use on cognitive decline. Only age significantly predicted declines on the MMSE, immediate recall, and delayed recall.

Conclusion: The findings suggest sleep disturbances and associated treatment with benzodiazepine medications do not have a negative impact on cognitive function 8 years later. However, the study is limited by the unexpectedly low prevalence and self-reported exposures.

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0989

PATTERNS OF SLEEP AID USE IN OLDER AMERICAN WOMEN

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Introduction: Use of sleep aids can be associated with safety concerns among older women. Currently, little is known about trends in use of sleep aids in this population. We describe sleep aid use, overall and by class, in the Women's Health Initiative.

Methods: The Women's Health Initiative is a cohort study of women aged ≥ 50 years at baseline recruited from 1993-1998. Respondents were followed-up 3 years after baseline and 2010. At each wave respondents presented current prescription and over-the-counter medications.

Results: A total of 91,512 participants provided medication use data at all waves. A total of 6.7% of respondents used a sleep aid at baseline, compared to 7.3% in follow-up year 3, and 9.2% in 2010. At follow-up year 3, 4.0% of respondents were new sleep aid users, and in 2010, 5.8% of respondents were new users. Increases of any and new sleep aid use were consistent across age. Non-benzodiazepine sedative hypnotics, benzodiazepines, and sedative antidepressants accounted for the majority of sleep aid use at each wave. Non-benzodiazepine sedative hypnotic use was $< 1.0\%$ at baseline and follow-up year 3 and 3.6% in 2010. Benzodiazepine use was approximately 2.0% at baseline and follow-up year 3 and 4.7% in 2010. Sedative antidepressants use was between 2.0-3.0% at each wave. At follow-up year 3, $< 1.0\%$ of respondents were new users of non-benzodiazepine sedative hypnotics, while 1.2% of respondents were new users of benzodiazepines. In 2010, 2.9% of respondents were new users of non-benzodiazepine sedative hypnotics, while 3.6% of respondents were new users of benzodiazepines. New use of sedative antidepressants was around 1.0% at both follow-up year 3 and in 2010.

Conclusion: Sleep aid use in older American women increased from 1993-2010. This growth primarily reflects increased non-benzodiazepine sedative hypnotic and benzodiazepine use.

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0990

SLEEP AID USE AND PHYSICAL FUNCTION IN OLDER AMERICAN WOMEN

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Introduction: Sleep aids are related to increased risk of falls in older adults. We assessed objective physical functioning in a cohort of older women in relation to sleep aid use.

Methods: The Women's Health Initiative recruited women from across the U.S. aged ≥ 50 years at baseline in 1993-1998. Participants were interviewed again 3 years later. At baseline and follow-up year 3, women completed physical performance tests (chair rises, grip strength, and gait speed). At both time points women provided a medication inventory of all current prescription and over-the-counter medications, from which we selected medications likely used as sleep aids. Women provided demographic and health information at baseline. We used multivariate linear regression models to examine the relationships between sleep aid use and physical performance tests at baseline and between longitudinal patterns in sleep aid use with changes in physical performance measures between the two waves.

Results: A total of 5840 respondents completed ≥ 1 physical performance test at baseline, while 4836 respondents completed ≥ 1 physical performance test at both waves. At baseline, self-reported use of sleep aids was cross-sectionally associated with weaker grip strength (-0.82 kilograms (95% CI: -1.19, -0.45)) and slower gait speed (-0.03 meter/second (95% CI: -0.05, -0.01)), adjusting for baseline demographic and health characteristics. Self-reported use of sleep aids was not cross-sectionally associated with chair rise time. Patterns of sleep aid use at baseline and follow-up year 3 were not associated with change in physical performance test scores.

Conclusion: In older American women use of sleep aids is cross-sectionally related to poorer physical function. However, sleep aid use did not predict worse physical function decline.

Support (If Any): PhRMA Foundation Health Outcomes Research Starter Grant.

0991

TAILORED LIGHT TREATMENT IMPROVES SLEEP, DEPRESSION AND AGITATION IN PERSONS WITH DEMENTIA LIVING IN LONG-TERM CARE FACILITIES

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Introduction: Persons with Alzheimer's disease and related dementias (ADRD) are often difficult for family caregivers to manage because of sleep problems, nocturnal wandering, and associated daytime irritability. Preliminary studies using light therapy have shown that appropriately-timed light exposure can consolidate and improve nighttime sleep efficiency, increase daytime wakefulness, and reduce evening agitation. The present study was designed to test the effectiveness of a tailored light treatment on sleep quality, agitation and depression in those with ARDR living in nursing homes.

Methods: Low levels (300-400 lux at the cornea) of a bluish-white light source (correlated color temperature > 9000 K), expected to deliver high circadian stimulation to residents during the daytime hours, was installed in 14 nursing home resident's rooms for a period of four weeks. Light-dark and activity-rest patterns were collected using a calibrated instrument prior to and after the lighting intervention. Measures of sleep quality, depression and agitation were also collected using standardized questionnaires.

Results: Exposure to the tailored light treatment significantly ($p < 0.05$) increased global sleep scores from the Pittsburgh Sleep Quality Index. Light exposure also increased phasor magnitude, a measure of the 24-hr resonance between light-dark and activity-rest patterns, consistent with an increase in circadian entrainment. Light exposure significantly reduced depression scores from the Cornell Scale for Depression in Dementia and agitation scores from the Cohen-Mansfield Agitation Inventory.

Conclusion: A light treatment tailored to increase circadian stimulation during the day can be used to increase quality of life in those with ARDR. A larger study should be conducted to confirm the present results. Given that practical and effective systems such as the ones used in the present study can be designed and installed, light treatments could be beneficial to those with ARDR and their caregivers.

Support (If Any): National Institute on Aging (R01AG034157). Product donation: GE Lighting.

0992

IMPAIRED SLOW WAVE ACTIVITY DISSIPATION IN MILD COGNITIVE IMPAIRMENT

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Introduction: Slow wave sleep, physiologically slow wave activity (SWA), is a measure of the sleep homeostatic drive. SWA is high early in the night and decreases during sleep, reflecting dissipation of the homeostatic sleep drive. Slow wave sleep and SWA have been shown to play a role in learning and memory. Furthermore, SWA is reduced in people with amnesic mild cognitive impairment (aMCI), a neurodegenerative disorder which often evolves into Alzheimer's disease. Impaired dissipation of the homeostatic drive may also be related to aMCI. The aim of this study is to determine whether alteration in the homeostatic regulation of sleep is impaired in aMCI.

Methods: Seven patients with aMCI (age 74.9 ± 7.5 years, 1 male) and 15 age/sex-matched controls (age 72.9 ± 5.2 years, 2 male) underwent at least 2 nights of polysomnography. Spectral analysis (PRANA, PhiTools, France) was conducted on Night 2 to calculate SWA (0.5-4.5 Hz) during non-REM sleep. The proportion of SWA during non-REM sleep in each sleep cycle was plotted against the cycle midpoint relative to sleep onset. Subjects in each group were pooled together and points were fitted to an exponential decay function $y = SWA_0 * e^{-(k * \text{time})} + SWA_i$, where SWA_0 is the SWA at time = 0, SWA_i is the SWA at time = infinity, and k is the decay rate in %/min (higher k indicates faster decay).

Results: There were no group differences in total sleep time, sleep efficiency, or proportions of non-REM or REM sleep. Total non-REM SWA was less in the aMCI group compared to control but not statistically significant (18855 ± 88349 vs 25559 ± 10717 uV2, respectively). The aMCI group had slower SWA dissipation than controls (decay rate 0.0081 vs 0.024 %/min, respectively; $p = 0.001$). There were no group differences in total amount or proportion of SWA in any of the first three cycles.

Conclusion: Compared to controls, individuals with aMCI have slower SWA dissipation during sleep, indicating impaired ability to dissipate

the homeostatic sleep load. This finding may be related to cognitive dysfunction and needs to be confirmed in a larger sample and in men.

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0993

SLEEP IN LONG-TERM CARE RESIDENTS WITH DEMENTIA: PILOT OF A PERSON-CENTERED CARE INTERVENTION

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Introduction: Evidence suggests that more daytime physical and social activities enhance maintenance of the normal sleep-wake pattern in people with dementia. Person-centered dementia care (PCDC) aims to maintain personhood and improve well-being of people with dementia by providing care to fulfill the individualized needs of people with dementia and engaging them in meaningful physical and social activities. This pilot study aimed to examine the effect of a PCDC intervention on sleep in long-term care residents with dementia through reduction of daytime napping and increased physical and social interactions.

Methods: A pre-post controlled study of twenty-nine residents living in two dementia units at different assisted living facilities was performed. The PCDC intervention included 3 months of staff training (three training modules then supervision in practice). The twenty-four hour sleep/wake patterns were measured using Actiwatch for three consecutive days. Dementia care mapping was used to estimate daytime sleep, physical and social activity. Statistical analyses were performed using descriptive statistics, independent t-test, Chi-square statistic, and analysis of covariance on sleep variables.

Results: Seventy percent of staff working in the intervention unit completed all training modules. Nineteen residents from intervention unit and six residents from control unit completed the study. The PCDC intervention group had significantly more physical ($p = .02$) and social activities ($p = .01$), less minutes of daytime sleep ($p = .02$), less times of nighttime awakening ($p = .04$), higher night/day sleep ratio ($p = .001$), higher sleep efficiency ($p = .02$) than the control group, after adjusting for baseline differences. No significant differences were found in minutes of nighttime sleep and sleep latency between two groups.

Conclusion: PCDC approaches may be effective for improving sleep of residents with dementia in this study. Randomized controlled studies of larger sample size are needed to confirm the beneficial effect of PCDC on sleep of long-term care residents with dementia.

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0994

THE EFFECT OF EXERCISE ON SLEEP DURING PREGNANCY

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Introduction: Many pregnant women complain of poor sleep beginning in early pregnancy. Given that evidence implicates poor sleep as a risk factor for adverse pregnancy outcomes, it is imperative to find non-pharmacological methods to improve sleep. Exercise has been shown to improve sleep quality and continuity among non-pregnant populations. Presently, few investigations have examined the benefits of exercise on sleep during pregnancy.

Methods: The effects of time period and exercise on sleep efficiency in 183 pregnant women were investigated using repeated measures analysis of variance (ANOVA) while controlling for several covariates: Marital status, income, race, highest education level attained, age, BMI, caffeine consumption, depressive symptoms and perceived stress. Time period consisted of three levels (weeks 10-12, weeks 14-16, weeks 18-20 gestation). Exercise was treated as a time-varying dichotomous variable: Those who exercised according to American College of Obstetrics and Gynecology (ACOG) guidelines (> 500 MET minutes/week) and those who did not. A natural log transformation of sleep efficiency was employed as the dependent variable to satisfy the normality assumption.

Results: The main effect of time period was statistically significant ($p = 0.02$). Sleep efficiency increased over time in the sample as a whole. The main effect of exercise on sleep efficiency was not statistically significant ($p = 0.28$). However, the interaction between time period and exercise had a significant effect on sleep efficiency ($p = 0.037$). Further investigation of this interaction revealed a small but significant difference between subjects who met ACOG guidelines compared to those who did not during the third time period ($p = 0.015$). No significant differences between exercise groups were observed during the first period ($p = 0.97$) or second period ($p = 0.75$).

Conclusion: These preliminary results suggest that incorporating the recommended amount of exercise in early pregnancy may impart positive effects on sleep. The interaction between exercise and sleep may have significant health implications, since positive health behaviors are associated with superior pregnancy outcomes.

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0995

PERINATAL SLEEP AND POSTPARTUM DEPRESSION

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Introduction: Research has shown that a bi-directional relationship exists between sleep and depression. Comparatively little research has investigated whether similar relationships exist between sleep and postpartum depression (PPD). Current research within this field is limited by cross-sectional designs and reliance upon subjective measures of sleep. Polysomnographic (PSG) evidence is lacking. The aims of this study were to: 1) examine longitudinal changes to sleep and fatigue from late pregnancy through to twelve weeks postpartum, and 2) examine relationships between subjective sleep, PSG-measured sleep, fatigue and PPD.

Methods: Participants included healthy perinatal women ($n = 29$) who were asked to complete a week of sleep diaries along with the Multidimensional Assessment of Fatigue Scale and the Edinburgh Postnatal Depression Scale (EPDS), during the third trimester of pregnancy and at one and twelve weeks postpartum. Additionally, participants underwent one night of home PSG during the third trimester of pregnancy.

Results: A series of repeated-measures ANOVAs revealed that, compared to late pregnancy and twelve weeks postpartum, the first postpartum

week was characterised by significantly less total sleep time (TST), more awakenings, more daytime napping and increased fatigue ($ps < .05$). Multiple linear regression analysis showed that increased sleep onset latency and increased total amount of sleep during late pregnancy significantly predicted week 1 EPDS scores, after accounting for depressive symptoms during pregnancy ($R^2 = .554$, $F(2,23) = 11.01$, $p < .001$). The strongest predictor of week 12 EPDS scores was depressive symptoms during pregnancy ($R^2 = .641$, $F(1, 18) = 28.59$, $p < .001$). In contrast there were no significant correlations between pregnancy PSG sleep stage variables and PPD scores.

Conclusion: Women experience significant changes to sleep across the perinatal period, with the poorest sleep occurring in the first postpartum week. Difficulty falling asleep, increased TST and symptoms of depression during late pregnancy, significantly increase the risk of developing PPD.

0996

PSYCHOSOCIAL PREDICTORS OF SLEEP QUALITY AND QUANTITY DURING THE SHORT-TERM POSTPARTUM

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Introduction: The challenge of achieving adequate and restful sleep in the postpartum may not fully resolve by the time new mothers return to work. Accordingly, continued investigation into modifiable factors that may help or hinder sleep quality and quantity during this time is warranted. The current study sought to explore psychosocial predictors of sleep quality and quantity in first-time mothers across one week during the short-term postpartum (STP: 3-6 months).

Methods: Seven days of actigraphy, online sleep diaries and online daily diaries were collected from 30 primiparous mothers in the STP [M age = 29.43; 50% employed outside the home (EOH), 50% stay at home (SAH); 98% Caucasian]. Sleep diaries asked participants to rate their sleep quality (SQ; degree to which they felt rested from 1 = not at all rested to 7 = very rested) and report their total number of perceived awakenings (WAK). Daily diaries asked participants to report the number of alcoholic drinks (ALC) consumed during the day. Composite negative affect (NA) and perceived stress (PS) scores were derived from relevant daily diary responses to Profile of Mood State items. Total sleep time (TST) was estimated with actigraphy (10-minute SOL Medium Wake Threshold).

Results: Multilevel modeling methods were used to explore the relationships of NA and WAK to SQ and PS and ALC to TST. SAH mothers rated their SQ significantly higher than EOH mothers ($B = 5.97$, $SE .24$, $p < .05$). Across groups, SQ significantly decreased by .45 for every one unit increase in NA and for every additional WAK, SQ decreased significantly by .37. SAH mothers also slept significantly longer than EOH mothers ($B = 456.62$, $SE = 11.16$, $p < .05$). Across groups, TST decreased significantly by 17.32 minutes for every ALC and decreased significantly by 16.19 minutes for every one unit increase in PS.

Conclusion: These data suggest that SAH mothers had both higher SQ and longer TST than EOH mothers. However, across groups, increases in NA and WAK were related to lower SQ and increases in ALC and PS were related to shorter TST. Although some mothers may not have a choice in returning to work in the STP, they may be able to improve their sleep by acting upon the modifiable risk factors reported here (i.e., reducing alcohol consumption, managing stress, increasing daily positive affect, etc.).

Support (If Any): KU Sandy Dinoff Memorial Health Psychology Award; KU Behavioral Sciences General Research Fund.

0997

OBSTRUCTIVE SLEEP APNEA AND NEUROCOGNITIVE FUNCTION AMONG HISPANIC/LATINO MEN AND WOMEN: RESULTS FROM THE HISPANIC COMMUNITY HEALTH STUDY

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Introduction: We aim to examine the association between obstructive sleep apnea (OSA) and neurocognitive (NC) function among community-dwelling Hispanic/Latino men and women.

Methods: Cross-sectional analysis of the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) middle-aged and older adults (45-74 years old) with NC test at baseline (2008-2011). The main outcomes were the NC scores for Word Fluency (WF), the Brief-Spanish English Verbal Learning Test (B-SEVLT) and the Digit Symbol Substitution (DSS) test. Obstructive sleep apnea was obtained with the apnea risk evaluation system (ARES) and defined by the apnea-hypopnea index (AHI). Linear regression models were performed to evaluate relations between the AHI and NC scores by gender and age groups.

Results: The analysis consisted of 8059 participants, mean age of 56 years, 55% women and 41% with less than high school education. The mean AHI was 9.0 (Range 0-142). Mild, moderate and severe OSA was seen in 26%, 11%, and 7% of the sample, respectively. The AHI was inversely associated with WF ($\beta = -0.023$); B-SEVLT-sum ($\beta = -0.022$); and-recall ($\beta = -0.010$); DSS ($\beta = -0.050$) at $p < 0.01$. These associations were fully attenuated by the covariates. We further observed an interaction between the AHI and gender ($p < 0.01$). Female sex was inversely associated with WF ($\beta = -0.027$, $p < 0.10$), B-SEVLT-sum ($\beta = -0.37$), B-SEVLT-recall ($\beta = -0.010$) and the DSS ($\beta = -0.061$) at $p < 0.01$ adjusting for age, BMI, tobacco use, depression and anxiety scores, stroke, diabetes, hypertension and field center. These associations were not observed in Hispanic/Latino men.

Conclusion: In our study, the apnea hypopnea index was inversely associated with worse neurocognitive function in Hispanic/Latino women. Further investigation into the causes of worse neurocognitive function in women with obstructive sleep apnea is warranted.

Support (If Any): The Hispanic Community Health Study/Study of Latinos was carried out as a collaborative study supported by contracts from the National Heart, Lung, and Blood Institute (NHLBI) to the University of North Carolina (N01-HC65233), University of Miami (N01-HC65234), Albert Einstein College of Medicine (N01-HC65235), Northwestern University (N01-HC65236), and San Diego State University (N01-HC65237). The following Institutes/Centers/Offices contribute to the HCHS/SOL through a transfer of funds to the NHLBI: National Institute on Minority Health and Health Disparities, National Institute on Deafness and Other Communication Disorders, National Institute of Dental and Craniofacial Research, National Institute of Diabetes and Digestive and Kidney Diseases, National Institute of Neurological Disorders and Stroke, NIH Institution-Office of Dietary Supplements.

0998

AN EVALUATION OF THE DISTRIBUTION OF BODY MASS INDEX IN A LARGE SAMPLE OF SWEDISH MEN AND WOMEN WITH DIFFERENT HABITUAL SLEEP PATTERNS

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Introduction: Most previous studies on the association between sleep and body weight have focused on the mean or the upper tail of the frequency distribution of body mass index (BMI). The aim of the current study was to evaluate the entire distribution of BMI among individuals with different habitual sleep patterns.

Methods: Participants in the baseline cross-sectional survey of a general-population cohort established in Sweden in 1997 ($n = 40,197$; 64% women) reported their sleep duration on workdays and work-free days, sleep quality, daytime sleepiness, weight, height and possible confounders in questionnaires. We estimated associations between sleep patterns and seven percentiles (5th, 10th, 25th, 50th, 75th, 90th, 95th) of the BMI distribution using quantile regression.

Results: Compared with normal-duration sleepers (6-8 h), short sleepers (≤ 5 h) showed small differences at the 10th percentile of BMI (0.06 kg/m² in men, -0.08 kg/m² in women), after adjusting for age, education, physical exercise, smoking, alcohol consumption, and work schedule. The 90th percentile of BMI among short sleepers was larger than among normal-duration sleepers (0.99 kg/m² in men, 1.12 kg/m² in women). Similar associations were found with long sleep (≥ 9 h), poor-quality sleep and daytime sleepiness in women only. Short sleep on work-free days was associated with increases in the large percentiles of BMI in men only. In stratified analyses, all relationships except the one with daytime sleepiness were observed both among those who reported snoring and those who did not.

Conclusion: The largest differences in BMI between individuals with different habitual sleep patterns were observed at the upper extreme of the BMI distribution. Here, individuals with short, long or poor-quality sleep had a larger BMI than those with normal-length or good-quality sleep. Some of these sleep-BMI associations differed between sexes, but they were not mainly due to snoring—a marker of sleep apnea.

0999

PATTERNS OF NARCOLEPSY-ASSOCIATED BURDEN OF ILLNESS IN MEN VS. WOMEN: FINDINGS FROM THE BURDEN OF NARCOLEPSY DISEASE (BOND) DATABASE

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Introduction: Associations between narcolepsy and certain comorbidities and concomitant healthcare costs have been identified; however, there have been no large database analyses of sex-related patterns of narcolepsy burden of illness.

Methods: Five years of medical claims data were accessed using Truven Health Analytics MarketScan® Databases (> 50 million insured persons). Eligible subjects included adults who were continuously insured between 2006 and 2010 and had at least one narcolepsy diagnosis code. Non-narcolepsy controls were matched 5:1 on multiple factors. Extensive subgroup analyses were performed to validate the population.

Results: The analysis population included 9,312 with narcolepsy and 46,559 matched controls (59.2% female; mean age 46.1 y). Both male and female narcolepsy patients had a significantly greater number of comorbid diagnoses compared with controls, including many conditions

not previously associated with narcolepsy. Regardless of narcolepsy status, odds ratios for almost all comorbidity categories were higher in females vs. males; this finding was even more pronounced within the narcolepsy cohort, with the exceptions of obstetrics/fertility and perinatal categories. Healthcare service utilization rates were significantly higher among narcolepsy patients vs controls for both men (17.6 vs. 8.5 services/pt/yr; $P < 0.0001$) and women (24.0 vs. 11.8 services/pt/yr; $P < 0.0001$). The mean number of annual drug transactions was similarly greater in narcolepsy patients vs controls for both sexes (males, 22.3 vs 11.5 transactions/y; females, 29.3 vs. 14.5 transactions/y; both $P < 0.0001$). Costs and drug utilization followed a similar pattern. In both narcolepsy and control cohorts, utilization of services was higher in female vs. male patients (36.4% excess and 38.8% excess, respectively). **Conclusion:** Narcolepsy entails a significant burden of illness in both men and women as measured by comorbid illness (including illness categories not previously associated with narcolepsy), healthcare utilization, and costs. A greater illness burden was observed in women compared with men.

1000

GENDER DIFFERENCES IN THE ASSOCIATION OF IMPAIRED SLEEP ON MOOD AND FUNCTIONAL OUTCOMES IN ADULTS WITH T2DM

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Introduction: Daytime sleepiness is known to negatively affect mood and functional activities sensitive to sleep disruption. It remains unclear if there are differences between men and women in their response to impaired sleep. The purpose of this study in adults with type 2 diabetes (T2DM) was to examine gender differences in the association of sleep quality and daytime sleepiness with mood and functional outcomes.

Methods: This study was an analysis of cross-sectional baseline data ($n = 113$) of adults with T2DM evaluated in a RCT on obstructive sleep apnea and physical activity. Measures included the Epworth Sleepiness Scale (ESS), Pittsburgh Sleep Quality Index (PSQI), Profile of Mood States (POMS), and the Functional Outcomes of Sleep Questionnaire (FOSQ). Data were analyzed using descriptive and inferential statistics. Statistical significance was set at $p < .05$.

Results: The sample was well distributed by sex and race (56% female; 53% non-Caucasian), primarily middle-aged (Mean \pm SD = 52.58 ± 9.24 years, range = 31-82), overweight or obese (mean BMI = $35.05 \text{ kg/m}^2 \pm 6.75$), and had sub-optimal glucose control (mean A1C = $7.3\% \pm 1.5$). The majority had poor sleep quality (PSQI = 10.94 ± 3.95 , $80\% > 5$) and were subjectively sleepy (ESS = 12.18 ± 4.06). There was no statistically significant difference in age, BMI, A1C, PSQI or ESS between males and females. Males had significantly higher scores on POMS Vigor ($t = 2.45$, $p = .001$) and FOSQ General Productivity ($t = 3.49$, $p = .016$) compared to females. Males had a significant associations between the PSQI and the POMS Total Mood Disturbance ($r = .512$, $p = .001$) and between PSQI and FOSQ ($r = -.528$, $p < .001$); in females PSQI was not significantly associated POMS but was significantly associated with FOSQ ($r = -.39$). Subjective sleepiness was not significantly associated with decreased FOSQ in male subjects but was in female subjects ($r = -.51$, $p < .001$).

Conclusion: Results suggest there may be a difference in how men and women with T2DM express the effects of poor sleep quality and daytime sleepiness on mood and functional outcomes.

Support (If Any): This research was supported by a grant from the National Institutes of Health, National Heart Lung and Blood Institute HL 089522 (E. Chasens) and through Grant Numbers UL1 RR024153 and UL1TR000005. CPAP and sham-CPAP devices obtained via loan agreement from Philips Respironics, Inc.

1001

INVESTIGATING THE EFFECTS OF SLEEP INERTIA ON SELF-REPORTED MOOD BY SEX

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Introduction: Only one study to date has analyzed the effects of sleep inertia on mood following a nap. Hayashi and Watanabe (1999) found that mood and performance did not significantly improve until 1-2 hours following a nap. In addition, no studies have examined the differential effects of sleep inertia in males and females. This study aims to investigate the effect of sleep inertia following a 60-minute nap on a participant's self-reported mood in both males and females.

Methods: A sample of 10 participants (5 male, 5 female) were recruited for a larger study regarding the effects of naps on emotional reactivity. Participants were asked to keep a consistent sleep schedule beginning 3 days prior to the study, verified by a sleep diary and calls into a time stamped voicemail. Participants were randomly assigned to either a 60-minute nap opportunity or a 60-minute film viewing. All participants completed a series of questionnaires, including the Positive Affect Negative Affect Schedule (PANAS; Watson & Clark, 1988) to self-report positive and negative mood before napping and 5-10 minutes after waking from the nap.

Results: Two series of analyses were conducted on positive and negative mood measures, respectively, using responses from the PANAS. A repeated measures ANOVA revealed that there was a trend towards a significant interaction between positive mood and sex immediately following a nap ($p = 0.1$). ANOVA also showed a significant decrease in positive mood for all participants after the nap as compared to before the nap ($p = 0.03$). Further analysis revealed a significant main effect between both sexes, in which females demonstrated a lower positive mood than males immediately after the nap ($p = 0.05$). However, repeated measures ANOVA on negative mood measures from the PANAS revealed no significant interaction between negative mood and sex following a nap, and no significant main effects of a nap on negative mood for participants as a whole.

Conclusion: Results revealed that sleep inertia following a brief 60-minute nap may have a greater effect on positive mood in females than that of males. In addition, results indicated that positive mood decreased immediately following a nap. While study limitations including the current small sample size bias the results, the results suggest that the effects of sleep inertia on mood has sex-based effects.

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SLEEP AND YOUR RELATIONSHIP, IT'S NOT ABOUT LAST NIGHT

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Introduction: The majority of adults share a bed with a romantic partner, but sleep research has typically focused on sleep as an individual behavior. Sleep and relationship quality may influence each other in a bidirectional manner: Poor relationship quality may affect sleep, and poor sleep may perturb relationship quality. In this prospective, naturalistic study, we examined the relationship between nightly sleep and daily marital quality in a sample of healthy, couples.

Methods: Forty-eight heterosexual, co-sleeping couples completed electronic diaries and wore wrist actigraphs for an average of 10 days. Marital quality was assessed daily with 4 items that assessed positive interactions (e.g., felt valued) and 4 items that assessed negative inter-

actions (e.g., felt criticized). Sleep variables were: actigraphy-assessed sleep efficiency (SE), total sleep time (TST), and wakefulness after sleep onset (WASO), and diary-assessed sleep quality. A lagged, longitudinal design allowed examination of both between-person (i.e. average person-level sleep) and within-person effects (i.e. the night to night change in sleep for each participant) on next day's marital quality. Models were also run for the reverse direction (i.e., the effect of that day's relationship quality on that night of sleep).

Results: On average, poorer actigraphy-assessed SE ($B = -.30$), higher WASO ($B = .07$), and shorter TST ($B = -.05$), and poorer diary-assessed sleep quality ($B = -.15$) were associated with poorer marital quality ($p < .01$). There were no significant within-person effects on next day's marital quality. When examining the reverse direction (marital quality's effect on sleep), an increase in marital quality (relative to one's average) was associated with higher sleep quality that night ($B = .09$) for both husbands and wives. However, for TST, a decline in marital quality (relative to one's average) was associated with longer TST among men, but not among women ($B = -.94$).

Conclusion: While one bad night of sleep may not lead to relationship turmoil the next day, higher quality relationships may lead to better sleep that night, at least for women.

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1003

HOSTILE BEHAVIORS ARE ASSOCIATED WITH OBJECTIVE MEASURES OF SLEEP DISTURBANCE IN COUPLES

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Introduction: Sleep is a "shared" health behavior for most adults, and for many, sleep problems and relationship problems co-occur. Emerging research has begun to elucidate the dynamic links between sleep and relationship health. We report results from the first study to examine the association between sleep and close relationships, using objective measures of both sleep and relationship behaviors.

Methods: A sample of 48 healthy, cohabitating couples (mean age 31.2 years; 77% white) wore wrist actigraphs for an average of 10 days for assessment of habitual sleep patterns. Couples also attended a laboratory session during which they participated in a videotaped conversation about a source of conflict in their relationship. Couples' behaviors during the conflict were coded by an independent laboratory using a well-validated behavioral coding scheme. Analyses focused on the cross-sectional relationship between actigraphy-assessed sleep latency (SL), wakefulness after sleep onset (WASO), total sleep time (TST), and fragmentation index, and observer-coded positive (i.e., relationship enhancing) and negative (i.e., hostile) behaviors during the conflict. Multilevel models were used to examine the relationship between coded behaviors and each partner's sleep outcomes. These models accounted for interdependence within couples; were adjusted for depressive symptoms; and examined both the main effects of coded behaviors on sleep, and the interaction of gender and behaviors on sleep.

Results: Higher levels of hostile behavior among husbands was associated with greater sleep fragmentation ($B = .37$, $p < .05$) and longer SL ($B = .32$, $p < .05$); the effect was stronger for husbands' sleep than wives' sleep. There were no significant associations between relationship-enhancing behaviors and sleep.

Conclusion: Hostility is associated with a host of adverse health outcomes, including cardiovascular and inflammatory responses. These preliminary findings are the first to demonstrate that hostility in couples

is also associated with objective sleep disturbance, which could plausibly contribute to these other adverse outcomes.

Support (If Any): NIH HL093220.

1004

HOW DOES THE SLEEP ENVIRONMENT AFFECT SLEEP QUALITY AND SELF-REPORTED HAPPINESS IN COLLEGE WOMEN?

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Introduction: Much research has established that low mood and depression can result from poor sleep, but fewer studies have looked at the relationship between happiness and sleep quality. Previous research suggests that happily married women report fewer sleep disturbances and better sleep quality. Our pilot study examined happiness in college students, with a focus on bed-partners, the sleep environment, and sleep disturbance. We hypothesized that female students with regular bed-partners would also report more happiness, and better quality sleep, compared to students with roommates but no bed-partners.

Methods: Undergraduate students enrolled in psychology courses were invited to participate; 39 students (59% female; 14 first-year students, 22 sophomores, and 3 juniors/ seniors) provided informed consent. Three women reported regular bed-partners and no roommates. These participants were matched on age, year in school, and gender to seven other participants. Measures included: Pittsburgh Sleep Quality Index, Owl-Lark Scale, Oxford Happiness Questionnaire (OHQ), measures of health, anxiety, and stress, and a demographic questionnaire about the sleep environment.

Results: Scores on the OHQ and the Owl-Lark were significantly correlated in the full sample ($r = .38$, $p < .02$); eveningness was correlated with poor sleep ($r = -.40$, $p < .02$). PSQI was significantly correlated with lower happiness scores ($r = -.52$, $p < .01$). Scores for happiness were higher, although not significantly, in participants reporting bed-sharing compared to matched controls ($F = 4.1$, $p < .07$). Anxiety and stress were significantly lower in the bed-sharing sub-group ($F = 10.2$, $p < .02$). No differences with respect to sleep quality were detected.

Conclusion: Better quality sleep and regular bed-sharing in college females may be associated with lower stress. These findings are consistent with studies of happiness and sleep in older, married women. Follow up research on these relationships might shed light on the dynamics of the sleep environment and its relationship to daytime happiness.

1005

SLEEP QUALITY IN WOMEN WHO USE DIFFERENT CONTRACEPTIVE METHODS

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Introduction: The aim of this study was to evaluate sleep quality in women who use different contraceptive methods.

Methods: This study was a descriptive, cross-sectional survey. The data were collected from patients at the Family Planning Outpatient Clinic of the Federal University of São Paulo. Pittsburgh Sleep Quality Index (PSQI) was used to evaluate sleep quality, and a questionnaire was used to obtain sociodemographic, clinical, lifestyle, and contraceptive use data.

Results: The study population comprised 235 women in reproductive age (from 19 to 45 years old). The results revealed that the mean age of the population was 31.3 ± 7.6 years. Regarding lifestyle, 25.5% of the women were physically active, 12.3% were smokers, and 70.6% drank coffee daily. Sleep quality was good in 34% of the studied population and poor in 66% of the population. Additionally, 69.4% of the women did not experience daytime sleepiness. The population was divided into two groups: hormonal (57.1%) and non-hormonal (42.9%) contraceptive users. The users of non-hormonal contraceptives (mean age = 34.2 ± 6.8 years) were older than the users of hormonal methods (mean age = 29.0 ± 7.5 years). According to the PSQI scores, the sleep quality in the users of non-hormonal contraceptive methods was similar to that in the users of hormonal methods (6.1 ± 3.2 versus 5.9 ± 2.9 ; $p = 0.5$). Sleep efficiency was statistically higher among the users of non-hormonal contraceptive methods (94.7 ± 17.7) than among the users of hormonal methods (90.0 ± 15.3 ; $p = 0.03$). The patients who had irregular or altered menstrual cycles reported poorer sleep quality. The absence of routine physical activity negatively influenced sleep quality ($p = 0.05$). The women who snored reported worse sleep quality ($p = 0.002$).

Conclusion: Nearly half of the studied population were users of hormonal contraception, and most of these women reported poor sleep quality. Sleep efficiency was higher among the users of non-hormonal contraceptives.

Support (If Any): AFIP.

1006

DEMOGRAPHIC, SOCIOECONOMIC, AND HEALTH DIFFERENCES IN CIRCADIAN ACTIVITY-REST RHYTHMS IN A DIVERSE COMMUNITY SAMPLE

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Introduction: Analysis of circadian activity-rest rhythms, collected through wrist-worn actigraphy, provides an important index of functioning and recovery and has been used in some clinical populations. However, few studies have examined actigraphy in community samples. The current study examined demographic, socioeconomic, and health factors in relation to activity-rest rhythm differences within a diverse, community sample of women.

Methods: The current analyses focused on a sample of 266 women who participated in the Midlife in the U.S. (MIDUS) Biomarker study. Participants were recruited from rural and urban locations, resulting in a socioeconomically and racially diverse sample. Data were collected via telephone interview and two weeks of actigraphy. For the actigraphy data, double cosiner analysis was used to compute R^2 (overall robustness of rhythm), mesor (mean activity level), amplitude (height of rhythm), and acrophase (time of day that rhythm peaks).

Results: Multiple regression analyses were used to determine the variance in actigraphy variables explained by demographic (age, race), socioeconomic (income, education level), and health (body mass index [BMI], physical health, depressive symptoms) factors. A less robust rhythm was associated with non-white race ($p < .001$), higher education level ($p < .05$), and higher BMI ($p < .05$). Lower activity level was evident in participants who were older ($p < .01$), white ($p < .001$), had higher BMI ($p < .01$), and had worse physical health ($p < .05$). Lower rhythm height was associated with older age ($p < .05$), higher BMI ($p < .01$), and worse physical health ($p < .01$). Finally, a later acrophase was found in younger ($p < .01$) and more depressed ($p < .01$) participants.

Conclusion: Older age, higher BMI, and reports of poorer physical health most consistently predicted less optimal circadian activity-rest rhythms. These findings are helpful in understanding various risk factors for activity-rest dysregulation in females in the general community.

1007

PREVALENCE OF INSOMNIA AMONG WOMEN VETERANS ACROSS THE NATION

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Introduction: In the US, the prevalence of insomnia is higher among active duty servicewomen compared to servicemen. Our prior work found rates of insomnia $> 40\%$ among women veterans who receive VA healthcare in one healthcare system. This study sought to establish the national prevalence of insomnia among a nationwide sample of women veterans of all ages who receive VA healthcare.

Methods: Administrative VA data were used to identify women Veterans ($> 300,000$) who received VA healthcare within 6 months at any VA facility. A random sample of 4,000 was selected to receive a postal survey addressing ICSD-2 insomnia criteria using a 2-step mailing procedure followed by an opportunity to complete the survey by telephone. A pre-specified algorithm was applied for each of the insomnia criteria (A: disturbed sleep; B: despite adequate opportunity/circumstances; C: with daytime consequences; D: lasting > 3 months).

Results: 1559 women returned completed surveys [response rate = 39%; mean (SD) age = 52 (15) years]. 94.6% of responders met Criterion A (disturbed sleep), of whom 78.2% had adequate circumstances for sleep (Criterion B). Of those, 97.1% reported daytime consequences (Criterion C). 91.5% of women meeting criteria A-C reported sleep problems lasting > 3 months. Overall, 65.1% [95%CI = (62.7%, 67.5%)] met all 4 criteria. Insomnia rates varied as a quadratic function of age, with predicted insomnia rates at ages 20, 40, 60, and 80 years of 60.4%, 67.5%, 65.7%, and 54.3% (respectively). The maximum predicted insomnia rate was at age 29 (67.5%).

Conclusion: Using a national sample and rigorous survey methodology, this study confirmed that the prevalence of insomnia among women veterans is extremely high. Studies are needed to identify best practices models of care for this considerable segment of the women veteran population with insomnia disorders.

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1008

SLEEP DURATION AND CONTINUITY IN NULLIPAROUS WOMEN

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Introduction: Insufficient sleep and poor sleep quality among pregnant women have been associated with adverse pregnancy outcomes. However, data regarding the frequency of and factors associated with sleep disturbances among pregnant women are lacking. Our objective was to determine sleep duration and continuity among nulliparous women, and to identify factors associated with variations in these sleep measures.

Methods: Women enrolled in the nuMoM2b study, a multi-center prospective cohort study of nulliparous women with a singleton gestation, were recruited at the 2nd study visit (16 0/7-21 6/7 weeks') to wear an actigraph (ActiWatch, Philips Respironics) for 7 consecutive days. Sleep duration and continuity (measured by sleep fragmentation index, sleep efficiency, and wake time after sleep onset (WASO)) were studied in relation to factors previously associated with poor sleep quality (BMI, race/ethnicity, household income).

Results: Actigraphy-derived sleep data ($n = 369$) indicates that median sleep duration was 7.5 (IQR 0.9) hours and was significantly in-

fluenced by race/ethnicity with white, non-Hispanic women having the longest sleep duration ($p < .0001$). All sleep continuity measures were significantly associated with BMI, race/ethnicity and household income. Specifically, worse sleep continuity was seen in women with increasing BMI and in those with incomes below the poverty line; white, non-Hispanic women had better sleep continuity. With one exception, the demographic characteristics remained significant in multivariable models for the sleep continuity measures. For sleep fragmentation, poverty was no longer significant after adjustment for race/ethnicity.

Conclusion: Nulliparous women sleep > 7 hours per night, on average. However, sleep-continuity measures indicate a wide range in sleep quality that is impacted by BMI, race/ethnicity and household income. The causes of and pregnancy outcomes associated with variations in sleep quality warrant further investigation.

Support (If Any): NHLBI R01HL105549.

1009

EEG SPECTRAL ANALYSIS AND CHANGES IN DELTA POWER: THE EFFECTS OF TRIMESTER AND SLEEP-DISORDERED BREATHING IN PREGNANCY

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Introduction: In nonpregnant population it has been shown that slow-wave sleep (SWS) decreases in those with sleep-disordered breathing (SDB), compared to those without SDB. There are few electroencephalography (EEG) studies on sleep during pregnancy. Furthermore, the changes in EEG sleep parameters during pregnancy, and especially the possible changes in total SWS, are inconsistent. The aim of the study is to determine if SWS changes during pregnancy by using Power Spectral Analysis (PSA) and to test the hypothesis that a greater decrease in SWS during pregnancy occurs in women with SDB.

Methods: This is a secondary analysis of previous prospective study. Pregnant women ($n = 103$; mean age = 27.06 ± 7.22 yrs) completed sleep questionnaires and underwent full lab-polysomnography in the first and third trimesters. Ten and 27 women in the first and third trimesters, respectively, have AHI > 5 . Average spectral profiles were created for each NREM cycle after removing waking and movement epochs and epochs containing micro or miniarousals. Linear regression was performed to explore relationships between delta power and changes between two trimesters. Using delta power changes between two trimesters as the outcome variable, AHI changes and demographic variables having a $p < 0.2$ in a bivariate analysis were reevaluated in full linear regression models as independent variables.

Results: Delta power changed significantly between two trimesters ($b = -0.06$, $p = 0.019$, but the significance disappeared after adjusting for BMI (kg/m^2), total sleep time and frequency of naps per week ($b = -0.13$, $p = 0.051$). However, AHI changes between two trimesters were significantly associated with delta power changes, after adjusting for age, race, parity, BMI gain and changes in total sleep time between trimesters ($b = -0.019$, $p = 0.024$).

Conclusion: Delta power does not differ significantly between the first and third trimesters. However, PSG-confirmed obstructive sleep apnea (OSA) may alter the quantity of delta power between trimesters.

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1010

DELTA POWER BETWEEN GOOD AND POOR SLEEPERS IN PREGNANCY

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Introduction: Disturbed sleep and impaired sleep quality are common complaints during pregnancy. Sleep disturbances associated with decreased delta spectral power are potential risk factors for pregnancy complications. However, there are few electroencephalography (EEG) studies on sleep during pregnancy. In this study, we aimed to assess if delta power differs between good sleepers and poor sleepers across pregnancy. Thus, the power spectral analysis (PSA) of sleep EEG was performed in pregnant women in both the first and third trimester of pregnancy.

Methods: This is a secondary analysis of previous prospective study. Pregnant women ($n = 103$; mean age = 27.06 ± 7.22 yrs) completed sleep questionnaires including the Pittsburgh Sleep Quality Index (PSQI), and underwent full lab-polysomnography in both the first and third trimester of pregnancy. The PSQI is used to identify 'good sleepers' and 'poor sleepers'. Average spectral profiles were created for each NREM and REM cycle after removing waking and movement epochs and epochs containing micro or miniarousals. Random effect mixed linear regression analysis was used to explore relationships of delta power with sleep quality in NREM and REM cycles between two trimesters.

Results: Mixed models showed significant group (good sleepers vs. poor sleepers) differences in delta power between the first and third trimesters ($b = -0.064$, $p = 0.037$) after adjusting for age, objectively measured sleep efficiency, AHI, BMI, nap frequency, race and parity. Good sleepers had higher delta power than poor sleepers in both trimesters. Poor sleepers had lower delta power in the third trimester. However delta power in REM cycle did not differ between good and poor sleepers across pregnancy trimesters ($b = -0.041$, $p = 0.19$).

Conclusion: Women who are good sleepers had high delta power in both trimesters in comparison with women who are poor sleepers. Sleep disturbances modify delta power during slow wave sleep. Improving sleep quality may improve the outcomes of pregnancy which are associated with decreased delta power.

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1011

SLEEP DISTURBANCES AS A RISK FACTOR FOR CLINICAL DEPRESSION IN PREGNANT WOMEN

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Introduction: Sleep disturbance and depression are among the most prevalent symptoms reported by women during pregnancy. Available data on the association between sleep and symptoms of depression in pregnant women are sparse and methodological limitations are noted. This study aimed to examine objective and subjective sleep disturbances and risk for clinical depression in third-trimester pregnant women.

Methods: One hundred and sixty healthy third trimester pregnant women wore a wrist actigraph for 7 days to assess objective sleep quality and

quantity. Their subjective sleep quality was assessed by the Pittsburgh Sleep Quality Index (PSQI), with subjective poor sleep quality defined as a PSQI score > 5 . The Center for Epidemiologic Studies-Depression Scale (CES-D) was used to evaluate symptoms of depression. The presence of clinical depression was defined by a CES-D score ≥ 16 .

Results: Women were 31.93 ± 4.43 years of age at 32.71 ± 2.53 weeks gestation, and 110 (68.8%) worked full-time. Objective actigraphy data showed that 72 (45.0%) women slept < 6.5 hours a night, 109 (68.1%) women had a sleep efficiency $< 85\%$, and 30 (18.8%) women required more than 30 minutes to fall asleep. Seventy-four (46.3%) women had subjective poor sleep quality, and 31 (19.4%) women had clinical depression. Clinical depression risk was significantly increased in women with objective nighttime sleep < 6.5 hours (OR = 6.16) and subjective poor sleep quality (OR = 5.10).

Conclusion: Objective nighttime sleep < 6.5 hours and subjective poor sleep quality in healthy third-trimester pregnant women is associated with significant risks for clinical depression.

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BREAST-FEEDING FREQUENCY IN MOTHERS WITH HABITUAL SNORING IN PREGNANCY

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Introduction: The Surgeon General and the American Academy of Pediatrics recommend exclusive breastfeeding up to 6 months, but only 13% of babies are exclusively breastfed at six months. The frequency of breastfeeding is even lower among women with comorbidities such as hypertension, gestational diabetes, and depression. These conditions are also more common in pregnant women with symptoms of sleep-disordered breathing (SDB). Importantly, SDB symptoms affect up to 35% of women by the third trimester. However, it is not known whether SDB plays a role in the frequency of breastfeeding.

Methods: Pregnant women in their 3rd trimester were enrolled in a study of SDB and pregnancy outcomes. They completed a battery of sleep questionnaires including screening for SDB. Habitual snoring, as a surrogate measure of SDB, was defined as snoring ≥ 3 nights/week. Medical records were reviewed for infant feeding method at discharge and at the 6-week post-partum visit.

Results: Thus far data from 104 mother-infant dyads have been collected. The mean age of women was 32.3 ± 6.0 years and 45% were first time mothers. In total, 58% reported habitual snoring during pregnancy. Overall, exclusive breastfeeding occurred in 75% of women at discharge, with an additional 7% who breastfed and supplemented with formula. There were no differences in the frequency of exclusive breastfeeding at discharge between women with and without habitual snoring during pregnancy (72.1% vs. 70.5%). At the 6-week follow up, the frequency of exclusive breastfeeding had reduced to 30% in the non-habitual snorers and 21% in women who reported habitual snoring during pregnancy.

Conclusion: Women with SDB during pregnancy may constitute another group who warrant additional support and education regarding breastfeeding and its many rewards.

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SLEEP PATTERN GENDER DIFFERENCES AND FRAGMENTATION IN POSTPARTUM PARENTS OF TWINS

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Introduction: Parents of newborn twins are at risk for both sleep discontinuity and shortened sleep duration. As newborn care must occur each night and day, weekends may not offer respite and opportunities for "catch-up" sleep. In a pilot study of eight families, we found fathers of newborn twins experienced significantly less nightly sleep than mothers (5.4 versus 6.2 hours) at 2 weeks post discharge home. This prompted us to further examine sleep continuity, sleep duration and awakenings in parents of newborn twins.

Methods: Sleep-wake parameters were assessed using diaries and actigraphy in 104 families with newborn twins. Self-report and actigraphy-derived correlates of sleep-wake were obtained at two time points. Twins were 29.1 ± 10.8 days old at Time 1 and 92.0 ± 7.5 days old at Time 2. Actigraphy recordings of both parents commenced at 9:00 PM Saturday and terminated at 9:00 PM Tuesday.

Results: Actigraphy data were obtained from 89 families, of which 12 were unpartnered mothers. At Time 1, weekday total sleep time (minutes) over 24 hours was 414 ± 7.3 for mothers and 404 ± 10.4 for fathers. The longest uninterrupted sleep period (minutes) was 118 ± 3.3 mothers versus 137 ± 6.9 fathers. Mean number of night awakenings was $5.7 \pm .25$ mothers versus $3.8 \pm .31$ fathers. Time 1 weekend total sleep time over 24 hours was 428 ± 9.4 mothers; 426 ± 12.6 fathers. The longest uninterrupted sleep period was 136 ± 9.0 mothers; 139 ± 9.3 fathers. Mean number of night awakenings was $5.4 \pm .35$ mothers; $4.6 \pm .37$ fathers. Parental sleep patterns were similar at Time 2.

Conclusion: Sleep restriction is experienced by both parents regardless of day of week. The short duration of uninterrupted night sleep episodes and frequency of night awakenings highlight the fragmented nature of sleep for parents of twins.

Support (If Any): National Institute for Nursing Research, National Institutes of Health (R15-NR009797) and the Foundation for Neonatal Research and Education.

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REMOTE AMBULATORY MANAGEMENT OF VETERANS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: To date, there have been no prospective patient-oriented outcome studies in community-based populations combining out-of-center sleep testing (OCST) with telemedicine modalities to demonstrate usefulness of this OSA management approach. We piloted a novel, telemedicine-based OSA diagnosis and treatment pathway for adults.

Methods: Sixty patients (age 50.8, BMI 32.4 ± 5.5 kg/m², 55 males) at an off-site primary care facility referred for OSA evaluation were randomized to either in-person (INP) or telemedicine-based (TELE) management. Participants had an initial evaluation and 1- and 3-month follow-ups. Sleep providers saw INP participants at the off-site clinic. Providers used video-teleconferencing from the sleep center to the clinic for initial evaluation of TELE participants and phone calls for follow-ups. Participants completed the Functional Outcomes of Sleep Questionnaire (FOSQ) and Epworth Sleepiness Scale (ESS) prior to each encounter, and the Worker's Alliance Inventory (WAI) and Client Satisfaction Questionnaire (CSQ-8) afterward. All participants were evaluated for OSA by OCST, and were initiated on positive airway pressure for an apnea-hypopnea index (AHI) ≥ 5 events/hr (n = 38). Scores of the FOSQ, ESS, WAI, and CSQ-8 were compared between pathways using a Wilcoxon rank sum test.

Results: At baseline, mean ± SD FOSQ_{INP} = 13.50 ± 3.97 (n = 25); FOSQ_{TELE} = 13.30 ± 3.75 (n = 26) [p = 0.888]. Mean ± SD ESS_{INP} = 13.36 ± 5.54 (n = 25); ESS_{TELE} = 11.96 ± 5.34 (n = 26) [p = 0.390]. Mean ± SD WAI_{INP} = 67.12 ± 5.95 (n = 25); WAI_{TELE} = 63.54 ± 6.68 (n = 26) [p = 0.063]. Mean ± SD CSQ-8_{INP} = 20.16 ± 3.05 (n = 25); CSQ-8_{TELE} = 19.96 ± 1.84 (n = 26) [p = 0.825]. At 3-months, FOSQ_{INP} mean change = 1.26 ± 2.62 (n = 18); FOSQ_{TELE} mean change = 1.69 ± 3.63 (n = 13) [p = 0.984]. ESS_{INP} mean change = -1.94 ± 4.30 (n = 18); ESS_{TELE} mean change = -3.85 ± 5.43 (n = 13) [p = 0.457]. Mean ± SD WAI_{INP} = 70.67 ± 2.61 (n = 15); WAI_{TELE} = 67.22 ± 7.05 (n = 9) [p = 0.125]. Mean ± SD CSQ-8_{INP} = 20.67 ± 2.26 (n = 15); CSQ-8_{TELE} = 19.33 ± 0.87 (n = 9) [p = 0.122].

Conclusion: The data suggest that telemedicine compared to in-person management of patients with OSA results in similar functional outcomes, patient satisfaction with care, and patient relationship with the practitioner.

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RESIDUAL EFFECTS OF ESZOPICLONE ON DAYTIME ALERTNESS, PSYCHOMOTOR AND PHYSICAL PERFORMANCE

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Introduction: It is well known that physical activity or athletic ability cannot be exhibited to its full extent when the subject has a sleep disturbance or insufficient sleep the prior night. Distinguished athletes for international competitions may also suffer from jet lag, and this is also likely to interfere with their performances. In the present study, we

therefore evaluated effects of eszopiclone (2 mg) on sleep at night and psychomotor function, physical activity and subjective evaluation on the next day, in healthy university students.

Methods: In a double-blind cross-over study, 13 athletes received eszopiclone (2 mg) or placebo in two sessions over two nights. Residual effects on subsequent daytime functions were evaluated objectively by measuring psychomotor and physical performance using a combined test of finger dexterity, a simple discriminatory reaction test, memory test, critical flicker fusion test (CFF), vertical jump, and 50-m sprint, as well as subjectively (Alertness, Well-being, Fatigue), by visual analog scales.

Results: The accuracy rate of memory test showed significantly better results in the eszopiclone group than in the placebo group (88.4% vs 83.4%, p = 0.047). There was no change in well-being and fatigue scales on the following day in the eszopiclone session, but realm of daytime alertness was significantly worsened (r-ANOVA, p = 0.029).

Conclusion: Eszopiclone is an imidazopyridine with the half-life (T_{1/2} = 5-6 hours) and is known to have almost no affinity to benzodiazepine ω 2 receptor on GABAA receptor subunit and therefore has little muscle relaxant effect. Eszopiclone did not have serious side effects in athletic evaluation. Eszopiclone has a hypnotic activity without disturbing psychomotor and physical performance on the following day when given to healthy adults, suggesting eszopiclone may be used in healthy athletes to adjust their extrinsic sleep disturbances and their consecutive psychomotor and physical impairments.

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SLEEP IS FOOD FOR THE BODY: LATINO WOMEN'S PERCEPTIONS OF SLEEP AND ITS IMPACT ON EMOTIONAL, MENTAL AND PHYSICAL HEALTH

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Introduction: There is evidence indicating that Latinos in the U.S. experience short sleep duration. Socioeconomic and cultural factors may provide an explanation for why Latinos experience insufficient sleep. Insufficient sleep has negative physiologic and mental consequences. Because of the multiple life demands, such as childcare and work, and environmental factors, such as noise and light pollution, low-income Latino women experience insufficient sleep. However, few studies have examined the perceptions of sleep in this population. The purpose of this study was to describe the perceptions of sleep and its benefits, and the consequences of insufficient sleep among low-income Latino women of child-bearing age living in the U.S.

Methods: Thirty-four low-income Latino women, between the ages of 21-35, responded in writing to five semi-structured interview questions that elicited their perceptions of the importance of sleep and the impact of insufficient sleep on their health and daily lives. Responses to the five interview questions were coded and collated into themes. The themes that emerged from the data analysis were used during four dissemination focus groups to validate results with the study participants.

Results: The themes that emerged were "Sleep is the food for the body" where women explained how sleep was crucial to maintain and protect health. The second theme that emerged was "No sleep means I can't function." In this theme participants described how insufficient sleep affects their day-to-day activities and family duties.

Conclusion: Understanding how this group of Latino women perceives sleep and the impact of sleep deprivation in their lives will facilitate the creation of culturally sensitive programs that promote sleep in this underserved population.

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USEFULNESS OF PROMIS SLEEP QUESTIONNAIRES IN A SLEEP DISORDERS CLINIC

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Introduction: There is a need to assess sleep symptoms in a standardized fashion in sleep disorders clinics. The NIH Patient Reported Outcome Measurement System (PROMIS) initiative has developed two short forms assessing sleep disturbance (SD) and sleep related daytime impairment (SRI). These instruments are useful in research, but have yet to be evaluated in a clinical setting. We assessed the utility of these PROMIS questionnaires in a sleep disorders clinic.

Methods: The 8-item PROMIS SD and SRI questionnaires along with the Epworth Sleepiness Scale (ESS) were administered to consecutive patients in a new clinical program focusing on sleep disorders in type 2 diabetics. Questionnaires were available in English and Spanish, and completed in the waiting room prior to each physician encounter.

Results: Thus far, 49 patients have been seen with median age 66 years (IQR 57, 70); median apnea hypopnea index (AHI) 14.4 events/hour (IQR 7.8, 35.2); median body mass index 33.0 kg/m² (IQR 29.8, 36.3) and 51% female and 15 have returned following institution of therapy. All three questionnaires were completed at every visit. The SD and SRI scores are moderately correlated (Spearman's rho 0.66, $p < 0.01$). The SRI is more strongly correlated with ESS (rho 0.51, $p < 0.01$ for SRI vs. ESS; rho 0.17, $p = 0.24$ for SD vs. ESS). None of the questionnaires correlated with AHI (rho < 0.10). Among those re-evaluated, the improvement in SD and SRI was strongly correlated (rho 0.88, $p < 0.01$), and both were moderately correlated with change in ESS (rho 0.47, $p = 0.08$ for change in SD; rho 0.53, $p = 0.05$ for change in SRI).

Conclusion: Our results suggest use of the PROMIS SD and SRI questionnaires is feasible in a clinical setting and scores are responsive to treatment.

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SLEEP APNEA AND CARDIAC REMODELING, A CALL FOR ROUTINE ECHOCARDIOGRAM

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Introduction: Obstructive sleep apnea hypopnea (OSAH) exerts profound repetitive oxidative stress in the cardiovascular (CV) system early in the diseases process. Cardiac remodeling in the form of left atrial enlargement (LAE), diastolic dysfunction failure (DDFF), mitral, tricuspid valvular insufficiencies (MR, TR), interventricular septal hypertrophy (IVSH) and pulmonary hypertension (PAH) are common occurrences that are often overlooked in the diagnosis and treatment of OSAH. Once cardiac remodeling starts, OSAH increases CV morbidity and mortality. Since sleep medicine specialists are the first physician responder in OSAH, it is important to enhance awareness of CV consequences of OSAH even in the absence of cardiac symptoms and refer patients to cardiologists for echocardiogram and joint collaborative management of OSAH and heart disease.

Methods: 332 patients ages 12 to 96, M/F: 180/152 with OSAH underwent echocardiogram after a 6 minute walk test.

Results: 291 (88%) have LAE; 242 (73%) have MR, TR; 226 (68%) have DDFF grade 1; 12 (4%) have DDFF grade 2, 165 (50%) have PAH; 162 (49%) have IVSH. DDFF is observed as young as 12; PAH was seen as young as 14. DDFF grade 2 tends to be older > 60 . DDFF grade 1, 2 often does not exhibit any symptoms of dyspnea in the usual activity of daily living unless there is moderate exertion. We found out that once symptoms of dyspnea on moderate exertion occurs, cardiac remodeling such as any of the following LAE, MR, TR, DDFF, PAH, IVSH are often irreversible.

Conclusion: Serious CV consequences are seen in OSAH early on the disease process which if not diagnosed and treated promptly could lead to irreversible cardiac damage and heart failure. OSAH patients should be referred to cardiologist for early diagnosis and intervention shortly after OSAH is confirmed. At the very minimum, a 6 minute walk test followed by echocardiogram should be ordered in all OSAH patients.

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SELF SLEEP ASSESSMENT AND IMPROVEMENT: A DREAM MADE POSSIBLE BY MOBILE TECHNOLOGY

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Introduction: The modern society is "on" with no break ever. Sufficient sleep has become a luxury for many. Poor sleep resulting from hyper intense activity, frequent long distance flights, shift work, and prevalent sleep related disorders (OSA, PLMS) is an emerging epidemic. The availability of sleep diagnostics and treatment is limited, the costs are high, and the procedures are cumbersome for people who either perceive sleep as a luxury, or are not aware that they have a real problem. Thus most remain undiagnosed and untreated.

Methods: A smartphone is used to obtain mandatory information regarding sleep: (1) questionnaires about (a) Insomnia symptoms, (b) Delayed circadian tendency, (c) Hyper arousal, (d) Misconceptions, (e) General sleep habits; (2) Sleep diary with subjective daily self-reporting of (a) sleep quality, (b) napping and (c) stress during previous day as well as measured (d) Go to bed and (e) Wake up times. Optional objective data regarding sleep micro and macrostructure, sleep efficiency, stress level can be obtained when an off the shelf heart rate monitor belt is used to continuously record HR at night and evaluate sleep based on heart rate variability as a measure of autonomic nervous system function. When 5 out of 9 consecutive nights and the questionnaires are completed, a report, including a summary of the complaints and details (daily and mean values for total sleep time, sleep latency, go to bed, wake up time, sleep efficiency, wake, deep, light, REM sleep, awakenings, arousals and night stress) are delivered.

Results: Subjective sleep rating correlated with measured arousal index (48 measured nights, Pearson correlation $r = -0.282$, $p = 0.05$; and awakenings (-0.888 , $p = 0.04$); reported previous day stress correlated with measured sleep onset (-0.312 , $p = 0.05$). Measured sleep quality correlated with arousal index (-0.850 , $p < 0.0001$), measured stress index correlated with arousal index (0.0643 , $p < 0.0001$).

Conclusion: User friendly mobile solutions allow to acquire subjective and objective sleep information across multiple nights, making sleep assessment in the natural sleep environment feasible. This represents a necessary first step for sleep improvement.

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COMPARISON OF THE RESIDUAL APNEA HYPOPNEA INDICES OF THE POLYSOMNOGRAPHY AT THE SELECTED TITRATION PRESSURE AND FOLLOW UP VISIT POSITIVE AIRWAY PRESSURE DEVICE DATA: A REAL WORLD STUDY

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Introduction: In addition to delivering treatment, the positive airway pressure (PAP) devices have the capability to measure the residual apnea hypopnea index (rAHI). The criteria for device AHI determination are different from the AASM guidelines for the laboratory based studies. We utilized a novel real-world approach by comparing residual AHI at the recommended pressure during attended PAP titration polysomnography (PSG) with the rAHI determined by the PAP device at the follow up visit in 30-90 days.

Methods: Retrospective analysis of above mentioned variables was performed at a university-affiliated sleep center between August 2012 and June 2013. Statistical analysis included baseline descriptive statistics, Spearman's correlation and Bland Altman analysis.

Results: Out of 280 patients, 163 patients (41.7% male, 58.3% female, age 50.5 ± 12.8 years, BMI 38 ± 9.3 , severity-mild 22.7%, moderate 31.3%, severe 46%) were included based on a predefined criteria. In-laboratory PSG characteristics (IPAP 12.2 ± 4.7 cm of H₂O, rAHI 1.5 ± 2 , time of recording 78 ± 58 minutes) at the recommended pressure were compared with 30-90 days follow up visit PAP card data (mean pressure 12.2 ± 4.7 cm of H₂O, residual AHI 3.1 ± 2.7 , median daily use 283 ± 20 minutes). The rAHI was classified into two sub groups of either rAHI ≤ 5 or rAHI > 5 . 77% patients stayed in the same subgroup during the 30-90 days follow up visit. The sensitivity was 0.39 and specificity was 0.81. Spearman correlation coefficient was 0.128 ($p = 0.1$), Bland-Altman plot scatter showed overestimation of AHI at lower value and underestimation of AHI at higher values.

Conclusion: The rAHI in between two groups was poorly correlated. In contrast, we found that a large majority of patients (77%) stayed within the same subgroup (AHI ≤ 5 or > 5). This may be more clinically relevant. For instance a PSG rAHI of 1 and device AHI of 4, through poorly correlated, remain in the same subgroup of AHI < 5 suggesting optimal control. Furthermore, the sensitivity and specificity was comparable to a recently reported strictly protocolized event to event analysis (0.55 and 0.98 respectively). Finally, in 23% cases we found that the PAP device both over and underestimated the rAHI. It is unclear whether it represents poor device correlation or if these patients had persistent residual sleep apnea despite optimal treatment.

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A SIMPLIFIED METHOD FOR DISTINGUISHING SLEEP AND WAKEFULNESS

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Introduction: Evaluation of sleep state by conventional polysomnography (PSG) requires multiple electrode placements and time-consuming manual scoring. A simpler way of obtaining such information would add to the yield of unattended PSG and to the accuracy of level-3 testing.

Methods: An experienced sleep technologist scored sleep in 50 PSG records. Power spectra from the electroencephalogram (EEG: C3/A2 and C4/A1) were obtained for consecutive 3-second epochs throughout

each record (430,000 three-second epochs). Spectra were classified into 10,000 patterns based on the relative power of different frequency ranges. The probability of each pattern occurring during manually scored awake periods was determined (Odds Ratio Product; ORP). Assigned ORP ranged from 0 (occurs invariably during sleep) to 2.5 (occurs invariably during awake epochs). Intermediate values reflect patterns that occur in both states to different extents. To validate this index, we obtained 3-second ORP values in 56 new records. Average ORP in each 30-second epoch was calculated (44274 epochs). Two experienced technologists, not including the original scorer, scored the PSGs. Ability of ORP to predict the manual score was evaluated.

Results: When ORP was < 1.0 (56.6% of epochs) 93.4% of epochs were scored asleep by both scorers, 2.8% were scored awake and 3.8% received a split score. When average ORP was > 2.0 (18.5% of epochs), 91.4% were scored awake and 1.5% were scored asleep by both scorers and 7.1% received a split score. In the intermediate epochs (ORP 1.0-2.0; 25% of epochs) manual score was awake, asleep and split in 36.0, 43.8 and 20.2% of epochs. When both electrodes were of adequate quality ($n = 46$), agreement between ORP values in the two electrodes was excellent ($r = 0.94 \pm 0.03$)

Conclusion: A simple, automatically scored scale, utilizing one or two EEG electrodes, can provide a fairly confident assessment of when the patient was awake, asleep or in an intermediate state.

Support (If Any): YRT Ltd, Winnipeg; FMC Sleep Centre Development Fund.

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WAKING EEG ARTIFACT REJECTION TECHNIQUES: AUTOMATED AND VISUAL

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Introduction: Waking EEG studies provide useful contrasts for cortical activity during sleep. However, phasic eye movements and muscle artifact often influence the waking EEG. We compared quantitative waking EEG data in unedited records (UR), following only automated artifact rejection (AAR), and automated rejection combined with visual artifact rejection (AVR).

Methods: Ten waking EEG studies were collected using a standard protocol, with 5 minutes each of eyes open and eyes closed EEG. Subjects were 3 good sleepers and 7 insomnia patients (4 men, mean age 30.9; 6 women, mean age 38.8). EEG power was analyzed across six frequency bands (0.5-32 Hz) under 3 conditions: UR (no artifact rejection); AAR (validated EMG-based artifact rejection algorithm and validated REM detection algorithm); and AVR (automated artifact rejection methods plus visual editing). Visual editing permitted both the removal of epochs and the restoration of epochs removed by automated methods. Each method retained or eliminated data in 4-second epochs.

Results: In eyes open and closed conditions, the number of minutes retained for spectral analysis differed significantly across the 3 methods ($p < .001$; UR $>$ AAR, AVR). In the eyes closed condition, EEG power differed significantly ($p < .05$) among the 3 artifact rejection methods in all bands except 8-12 Hz and 16-20 Hz. In the eyes open condition, EEG power differed significantly among the 3 artifact rejection methods ($p < .05$) in all frequency bands. Both eyes closed and eyes open condition post-hoc tests indicated greatest EEG power in the UR condition, with no difference between AAR and AVR conditions.

Conclusion: Automated artifact rejection of waking EEG is associated with significantly reduced EEG power in most frequency bands in both eyes open and eyes closed conditions. Additional visual editing yields similar EEG power values compared to automated edit-

ing alone. Automated algorithms that target both eye movements and muscle artifacts seem to provide reliable spectral averages in waking EEG studies.

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FORMANT FREQUENCIES OF TRACHEAL BREATH SOUND AS A SCREENING METHOD FOR OBSTRUCTIVE SLEEP APNEA DURING WAKEFULNESS

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Introduction: The current method for Obstructive Sleep Apnea (OSA) diagnosis is full nocturnal polysomnography (PSG), an expensive and time-consuming procedure. During sleep, formant frequencies of breath sound previously allowed us to distinguish patients with OSA. In this study, our goal was to develop a screening procedure to identify OSA patients from breath sound analysis during wakefulness.

Methods: Respiratory sound was recorded by a tracheal microphone and synchronized to PSG recordings in 51 subjects suspected from OSA. Their apnea-hypopnea index (AHI) was determined from the PSG. Consecutive inspiration and exhalation episodes were identified in 20 subjects during their wake state before getting asleep. Formant frequencies of each episode were calculated using autoregressive spectral estimation. Each formant was characterized by its frequency, amplitude and depth. Formant features of inspiration and exhalation, and their variability in consecutive episodes, were studied. Subjects with AHI < 30 (N = 10, AHI 16.0 ± 9.3/h, BMI 26.5 ± 3.2 kg/m²) and AHI ≥ 30 (N = 10, AHI 51.9 ± 15.5/h, BMI 30.2 ± 2.8 kg/m²) were compared with Mann-Whitney U-test. The best formant features were selected for subject classification with Linear Discriminant Analysis.

Results: Formant frequencies coincided during inspiration and exhalation in most subjects. During inspiration, the formant located around 1 kHz had a higher frequency in subjects with AHI < 30 as compared to subjects with AHI ≥ 30 (F = 1170.7 ± 92.2 Hz vs F = 1078.6 ± 55.9 Hz, p < 0.05). The amplitude of this formant decreased (r = 0.55, p < 0.05) and its depth increased with the AHI (r = 0.8, p < 0.005). This formant frequency, together with the breath-to-breath variability of its depth, allowed to classify subjects with AHI ≥ 30 with sensitivity (specificity, accuracy) of 80% (77.8%, 78.9%). Using this formant frequency and the BMI, classification rates reached 90% (88.9%, 89.5%).

Conclusion: Formant frequency features of tracheal breath sound recorded during wakefulness are a promising tool for the screening of subjects with OSA. This technique may help prioritizing subjects before their enrolment for a full nocturnal PSG.

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VALIDATION OF THE BRFS SLEEP QUESTIONS

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Introduction: The Behavioral Risk Factor Surveillance System (BRFSS) is an on-going telephone health survey system run by the Center for Disease Control. Previously, sleep questions were added to the BRFSS, but never validated. The objective of this study was to validate the current BRFSS sleep questions then refine to establish succinct, questions with high predictive value of detecting sleep/wake disorders that contribute to health burden.

Methods: A two phase mixed methods prospective study of community-dealing residents was performed. Phase I subjects were recruited from the community at large to undergo study procedures. Participants attended one study visit where they completed questionnaires: ISI, ESS, SDQ, PROMIS-57 and demographics/medical, wore the Apnealink device for one night and wore a sleep diary/actiwatch for two weeks. BRFSS questions were answered at initial phone contact, during actigraphy measurement, at 30 days after study. Descriptive and correlation analysis of Phase I data were performed using SPSS. Phase II (30 random subjects from Phase I) refined the BRFSS questions utilizing interviews.

Results: 308 participants were enrolled. 66% females, 78% white, age M 41 (17), 26% had AHI > 5, ISI M 8 (6), ESS M 6 (4). BRFSS 1 (During the past 30 days for about how many days have you felt you did not get enough sleep) was significantly correlated with depressive symptoms and BRFSS questions 2 & 4. BRFSS 2 (On average, how many hours of sleep do you get in a 24-hours period) was significantly correlated with depressive symptoms and BRFSS 4 & 5. BRFSS 3 (Do you snore) was confounded with 19% of responses (I don't know or sometimes). BRFSS 4 (During the past 30 days, how many days did you find yourself unintentionally falling asleep) was significantly correlated with BRFSS 1, 2 & 5, severe snoring on Apnealink, anxiety and depression. BRFSS 5 (During past 30 days, have you ever nodded off driving?) was significantly correlated with BRFSS 1, 2 & 4.

Conclusion: Preliminary analysis revealed lack of specificity of the BRFSS questions in detecting sleep disorders. Significant high inter item correlations were discovered that can be addressed with factor analysis as well as further mixed methods analyses using Phase II interviews.

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1025

EXAMINATION FOR THE FACTOR STRUCTURE OF THE PITTSBURGH SLEEP QUALITY INDEX IN HEALTHY POSTMENOPAUSAL WOMEN AND THOSE WITH BREAST CANCER

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Introduction: Poor sleep is commonly reported by postmenopausal women, especially those with breast cancer (BC). The Pittsburgh Sleep Quality Index (PSQI) is a commonly used measure of sleep quality. It is crucial to evaluate the factorial structure of the PSQI in this population.

Methods: This is a secondary analysis of data from a NIH-funded longitudinal study of Anastrozole Use in Menopausal Women. Cohorts of 153 postmenopausal women with early stage BC and 100 healthy women matched on age and education are included. Data from the initial assessment (after surgery and before adjuvant therapy for women with BC) were used in this analysis. The PSQI is a 19-item self-report yielding seven sleep components characterizing sleep quality. The developers proposed a global score for overall sleep quality. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to explore the factor structure of the PSQI using seven components. Two factor models were hypothesized and tested for CFA using standard fit criteria (CFI, RMSEA).

Results: Women were white (94%) and middle-aged (Mean ± SD = 60.45 ± 6.17). EFA identified two factors: Perceived Sleep Quality with strong loadings for sleep duration [.815] and habitual sleep efficiency [.805]; and Sleep Efficiency with good to strong loadings for use of sleep medication (.871) and sleep latency (.661). Perceived Sleep Quality captured 39.73% of total item variance, whereas Sleep Efficiency retained 15.28% of total item variance. Using CFA the two-factor model of Sleep

Efficiency and Perceived Sleep Quality (RMSEA = 0.085, CFI = 0.959) has a better fit compared to the one-factor model (RMSEA = 0.104, CFI = 0.928); however, RMSEA suggests issues with fit for both models. **Conclusion:** Results are somewhat consistent with previous work showing the two-factor model as having the best fit in a similar population. Additional analysis in a larger sample is needed to investigate the two-factor model in each cohort.

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1026

VALIDATION OF THE ALLIANCE SLEEP QUESTIONNAIRE (ASQ) NARCOLEPSY MODULE IN SLEEP DISORDERED PATIENTS

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Introduction: The Alliance Sleep Questionnaire (ASQ) is a comprehensive, on-line, branching logic questionnaire comprised of validated measures and novel questions. It was designed to standardize clinical data collection and provide a Summary Report to streamline clinical appointments. Permission is obtained to use de-identified data for research. The Stanford Sleep Disorders Clinic (SSDC) adopted the ASQ as standard of care in September 2012. We investigated the ASQ's ability to predict a positive diagnosis of type 1 narcolepsy (with cataplexy).

Methods: The patient population consisted of new patients (treated and untreated) seen at the SSDC for sleep complaints. To be included in the analysis, individuals had to consent to participate in research, complete the ASQ narcolepsy module, and have clinical information available via electronic medical record. Using the ASQ, we categorized individuals as probable or negative for type 1 narcolepsy using a pattern of responses selected apriori. Probable classification required an Epworth Sleepiness Scale score > 10 plus cataplexy symptoms occurring more than once a month or endorsement of classic cataplexy triggers, such as telling/hearing a joke or laughter. Those not meeting criteria were considered negative. Data on sleep paralysis, hypnagogic hallucinations, naps, and sleep disturbances were collected, but not used in this model. A type 1 narcolepsy clinical diagnosis was considered the gold standard, defined as clear cut cataplexy plus positive MSLT and/or low CSF hypocretin levels. Atypical cataplexy or type 2 narcolepsy diagnoses were considered negative.

Results: 1005 patients met inclusion criteria (581 males, 424 females; mean age 47.2 ± 15.6 , range 18-96). Of the 1005, 15 individuals had type 1 narcolepsy based on gold standard clinical diagnosis (6 males, 9 females; mean age 37.8 ± 16.5 , range 23-67). The ASQ correctly identified 12 true positives, leaving 3 false negatives, resulting in sensitivity of 80%. Our ASQ algorithm identified 24 individuals as type 1 (12 false positives) for a 50% predictive value of a positive result. The ASQ correctly predicted 978 of the 990 true negative patients resulting in a specificity of 98.8% and a 99.7% predictive value of a negative result.

Conclusion: The initial scoring algorithm was reasonably successful at classifying individuals with and without type 1 narcolepsy. We believe sensitivity could be significantly improved by fine-tuning the pattern of responses after collecting data on more type 1 narcoleptics, a process currently underway. Once the final algorithm is identified, it will be validated in an independent cohort.

Support (If Any): Philips Respironics Foundation.

1027

THE COLLEGE SLEEP QUESTIONNAIRE: STRUCTURE AND INITIAL PSYCHOMETRIC PROPERTIES

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Introduction: The Spring 2011 American College Health Association National College Health Assessment (NCHA) demonstrates a professional practice gap in sleep education. Only 26% of students report having received information about sleep from their college or university, yet 53% of students report they are interested in receiving this information. There are validated ways to assess problematic drinking, depression, and stress in college students, but no published sleep questionnaire for this demographic. We developed the College Sleep Questionnaire to provide a research tool to assess the sleep schedule, sleepiness, and typical sleep disturbances of college students.

Methods: Questions were chosen after conducting literature reviews and focus groups with students, consulting with pediatric sleep physicians, and performing an item analysis of pilot questions. The questionnaire was pilot-tested ($n > 700$) and a subset of respondents was tested for test/re-test validity. For external validation, responses were compared to sleep items from the NCHA and the Epworth Sleepiness Scale.

Results: The survey consists of four categories: sleep strategies, sleep schedule, sleepiness, and sleep disruptions. The 'Sleep Strategies' section uses Prochaska's Stages of Change model to assess students' motivation to improve their sleep. The 'Sleep Schedule' section includes a weeklong 24-hour schedule on which students indicate when they typically sleep and nap. This instrument captures actual daily variations in scheduling that reflect different class times, work shifts, and athletic practices. From this section, researchers and clinicians are able to assess whether a student is allowing enough time for sleep, how day-to-day variability in the sleep schedule might be impairing sleep, and the extent of the weekend to Monday social jetlag. This section also asks questions about students' chronotype, sleep latency, and sleep inertia. The 'Sleepiness' section assesses excessive daytime sleepiness using questions germane to students' daily life. The 'Sleep Disruptions' section is separated into physical health, stress and time management, and sleep behaviors. Each column contains experiences that negatively impact sleep, and students are asked to check which they experience at least once a week. This section is designed to provide formative feedback to students and health professionals about particular factors to focus on to improve sleep.

Conclusion: The College Sleep Questionnaire is a useful tool to assess sleep health markers and impediments to college student sleep.

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1028

NOCTURNAL WAKE BOUT DURATION PREDICTS DAYTIME SLEEPINESS

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Introduction: Although the Multiple Sleep Latency Test (MSLT) is the gold standard for assessing sleepiness, it is a costly and burdensome procedure, making it impractical for routine clinical use. The Epworth Sleepiness Scale (ESS) is a less burdensome alternative, but its power to accurately and consistently identify sleepiness is questionable. There is clearly a need for a more clinically useful objective assay of sleepiness. In the present report, we employ polysomnographic bout analyses to predict MSLT scores in a population-based sample.

Methods: Data are presented from a subsample ($n = 84$) of a larger epidemiologic study. Subjects were randomly selected from a metropolitan area (mean age 42.2 ± 12.0 ; 51.2% female). On the study night, all subjects completed an ESS and a standard 8-hour polysomnogram, followed by an MSLT the next day. Nocturnal PSG data was analyzed by classifying sequential 30-second epochs into sleep and wake bouts. Each subject's mean wake bout duration was calculated for correlation with MSLT latencies.

Results: Mean duration of nocturnal wake bouts was positively correlated ($r = .42, p < .001$) with mean sleep latency on the MSLT, suggesting that longer durations of awakening during the night are associated with higher MSLT latencies. The ESS was negatively correlated to MSLT scores ($r = -.25, p < .001$). Linear regression of both predictors on MSLT latencies showed a significant standardized coefficient for wake bout duration ($b = .36, p < .001$) but not for ESS ($b = -.19, p > .05$).

Conclusion: Nocturnal sleep tendency, evidenced by longer wake bout duration on nocturnal PSG, was predictive of daytime sleep tendency on the gold standard MSLT. This suggests that nocturnal measures of wake (i.e., PSG wake bout characteristics) may provide a clinically useful objective measure of daytime sleepiness.

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DEVELOPMENT OF DEFINITION OF RESPONDER TO NARCOLEPSY TREATMENT

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Introduction: Responder analysis is important for assessing meaningful change to individuals in therapeutic trials. Our objective was to define responder criteria using an anchor-based approach for the outcomes of excessive daytime sleepiness (EDS) and frequency of cataplexy attacks in narcolepsy patients undergoing sodium oxybate treatment.

Methods: Data were pooled from two randomized, placebo-controlled, double blind, multi-center 4-wk and 8-wk sodium oxybate trials for the treatment of narcolepsy with cataplexy. Descriptive statistics and receiver operator characteristics (ROC) analysis were used to compare the anchor measure, the Clinical Global Impression of Change (CGIc), to the outcomes of change in weekly cataplexy attacks and the Epworth Sleepiness Scale (ESS) to establish patient reported responder criteria.

Results: Participants ($n = 364$) were 37.4% male, 87.9% white, with a mean age of 41.5 (15.3). Participants reported a median of 20 cataplexy attacks per week at baseline and a median ESS = 18. Forty-seven percent of the pooled sample participants were much or very much improved at the end of their trial based on CGIc ratings, 42% showed minimal or no change, 2% were much or very much worse, and for 9% the outcomes were missing. CGIc values of much improved were associated with a 55% reduction in cataplexy attacks per week and a 20% reduction in daytime sleepiness, on average. ROC analyses were used to assess the accuracy of patient outcomes in predicting a true response, defined as CGIc ratings of much or very much improved. Area under the curve values were 76.2% for % reduction in cataplexy attacks and 78.1% for % change in ESS score. We recommend cutoffs of 50% reduction in cataplexy attacks (sensitivity = 73%, specificity = 68%), and 20% reduction in EDS (sensitivity = 55%, specificity = 88%).

Conclusion: Weekly cataplexy attacks and EDS can be used to help identify responders to narcolepsy treatment using criteria of 50% and 20% reductions, respectively.

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the course of this employment, has received stock options exercisable for, and other stock awards of, ordinary shares of Jazz Pharmaceuticals.

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TREATMENT EFFICACY USING A TRIAL APPLIANCE TO DETERMINE THE OPTIMAL JAW POSITION FOR A CUSTOM ORAL APPLIANCE

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Introduction: This study evaluated OSA treatment outcomes resulting from use of a titration/trial appliance to define the jaw position for setting the custom oral appliance.

Methods: Twenty-three patients were fitted following a protocol that utilized a titration/trial appliance (TTA) (Apnea Guard®, Advanced Brain Monitoring, Carlsbad, CA) to determine the optimal protrusion and vertical positioning of the jaw for the custom mandibular repositioning device (MRD). Neutral and maximum protrusion were established with the TTA, with the retention material used as the bite registration for articulation of the MRD to exact jaw position of the TTA. Therapy was initiated with the TTA at 1-mm less than optimal protrusion to provide an opportunity for muscular adaption prior to delivery of the MRD at 70% protrusion. After insertion of the MRD, a home sleep test was performed. Adjustments to the MRD were only made if patients did not achieve a 50% reduction in the apnea-hypopnea index (AHI) from the pre-referral severity.

Results: The mean pre- and post-treatment AHI were 22 ± 10.2 and 6 ± 4.1 . Of those studied, 86% exhibited an overall AHI reduction of at least 50%; 77% reached the additional endpoint of $AHI \leq 10$. In two cases with reported AHI reductions of 41% and 42%, additional MRD adjustments did not improve outcomes. No side effects were reported as a result of: a) wearing the TTA while waiting for delivery of the MRD, or b) delivery of the MRD at 70% protrusion.

Conclusion: This study suggests the TTA provides a means to determine the jaw position for a MRD appliance that optimizes therapeutic outcomes. Patients benefited from being able to immediately initiate oral appliance therapy with the TTA, while waiting for the MRD to be fabricated. Follow-up results suggest that airway responsiveness, and not the jaw position predicted by the TTA, was the primary source of the non-response.

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LONG-TERM COST-EFFECTIVENESS OF UPPER AIRWAY STIMULATION FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA: A MODEL-BASED PROJECTION BASED ON THE STAR TRIAL

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Introduction: Upper airway stimulation (UAS) is a new approach to treat moderate-to-severe obstructive sleep apnea. Most recently, 12-month data from the STAR randomized controlled trial were reported, evaluating the effectiveness of UAS in patients intolerant or non-adherent to CPAP therapy. Our objective was to develop a decision-analytic model to assess the cost-effectiveness of UAS from a U.S. payer perspective.

Methods: A 9-state Markov model predicted cardiovascular endpoints (MI, stroke, hypertension), motor vehicle crashes (MVC), mortality, quality-adjusted life years (QALYs), and costs. Input parameters were derived from multivariate risk equations and other published sources.

Cost estimates for procedures and office visits were obtained from the FY 2013 Medicare Fee Schedule. We evaluated the impact of a mean AHI reduction of 16.7 from baseline 32.0, in a cohort with a mean age of 54.5 years, as observed in the STAR trial. We calculated the lifetime incremental cost-effectiveness ratio (ICER) in \$/QALY discounted at 3% per year for numerator and denominator, assuming maintenance of the demonstrated effect size beyond 12 months.

Results: UAS was projected to add 1.15 QALYs over the patient's lifetime, resulting from reduced or delayed cardiovascular events and a reduction in motor vehicle crashes. Costs were estimated to increase by \$43,513, resulting in a lifetime ICER of \$38,728/QALY.

Conclusion: Relative to the acknowledged willingness-to-pay threshold of \$50,000-\$100,000/QALY, our model projections suggest UAS is a cost-effective therapy in the U.S. healthcare system.

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THE AMERICAN ACADEMY OF SLEEP MEDICINE INTER-SCORER RELIABILITY PROGRAM: RESPIRATORY EVENTS

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Introduction: The AASM Inter-scorer Reliability program provides an opportunity to compare a large number of scorers with varied levels of experience to determine agreement in the scoring of respiratory events.

Methods: The sample included 15 monthly records, 200 epochs each with more than 3600 scorers. Scorers were asked to identify whether an obstructive, mixed or central apnea; a hypopnea; or no event was seen in each of the 200 epochs. The "correct" respiratory event score was the score endorsed by the most scorers. Percentage agreement with the majority score was determined for each epoch.

Results: The overall agreement for scoring of respiratory events was 93.9% (kappa = 0.92). There was very high agreement on epochs without respiratory events (97.4%) and the majority score for most of the epochs (87.8%) was no event. For the 364 epochs scored as having a respiratory event, overall agreement that some type of respiratory event occurred was 88.4% (kappa = 0.77). The agreement for epochs scored as obstructive apnea by the majority was 77.1% (kappa = 0.71), and the most common disagreement was hypopnea rather than obstructive apnea (14.4%). The agreement for hypopnea was 65.4% (kappa = 0.57) with 16.4% scoring no event and 14.8% scoring obstructive apnea. The agreement for central apnea was 52.4% (kappa = 0.41). A single epoch was scored as a mixed apnea by a plurality of scorers.

Conclusion: The study demonstrated excellent agreement among a large sample of scorers for epochs with no respiratory events. Agreement for some type of event was good, but disagreements in scoring of apnea vs. hypopnea and type of apnea were common. A limitation of the analysis is that most of the records had normal breathing. A review of controversial events yielded no consistent bias that might be resolved by a change of scoring rules.

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HIGHLY VARIABLE SLEEP APNEA: A NEW PHENOTYPE

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Introduction: We have confirmed a phenotype of highly variable sleep apnea using repeated ambulatory sleep polygraphy (ERS 2013 abstract 855387, CSS 2013 abstract 5818304). Our aim was to assess the prevalence, diagnostic significance, and demographics of this new phenotype.

Methods: From a convenience sample of 23,599 patients 1,011 (4.3%) were found to have two nights of sleep polygraphy. Complete demographics and technically acceptable polygraphy data were confirmed in all studies. Descriptive, agreement, and cluster analyses were performed on these duplicated studies (R 3.01, MClust 4.1).

Results: 70 of 1,011 (6.9%) repeated studies were found to have differences in estimated respiratory disturbance index (eRDI) greater than 20 / h between nights with 12 and 9 subjects having clinically false negative first night and second night studies using usual mild (less than 10 / h) and severe (greater than 30 / h) eRDI cut offs. Initially misclassified patients had equivocal pre-test risk of sleep apnea based on adjusted neck circumference (median 56.1 with IQR 40.8 to 88.6%). Bland-Altman analysis showed this highly variable subset was the main cause of between-night variation in eRDI. Bayesian information criteria clustering assigned most of the highly variable patients as outliers to a mid eRDI range cluster.

Conclusion: Highly variable sleep apnea: 1) can be clearly identified from ambulatory sleep polygraphy, 2) is the main cause of nightly disagreement in eRDI, 3) had a 7% prevalence in this large sample, and 4) occurs in patients with equivocal pre-test risk for apnea. Further study of mitigating false negative diagnoses and the effects of variable apnea on therapy prescription are suggested.

Support (If Any): Royal College of Physicians and Surgeons of Canada & Mitacs.

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VARIABILITY OF ELECTROENCEPHALOGRAPH SPECTRAL PATTERN IN PATIENTS WITH SLEEP DISORDERS

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Introduction: Conventional scoring of sleep during polysomnography (PSG) assigns a specific stage to each 30-second epoch in an all-or-none fashion. Yet, the electroencephalogram (EEG) in a given stage may look quite different in different patients and at different times. These differences may have physiological significance. Our objective was to determine the extent of variability in EEG spectral patterns between and within patients.

Methods: EEG Power spectra (C3/A2 and C4/A1) were obtained from consecutive 3-second epochs throughout 56 PSGs scored by two experienced technologists. The files covered a broad range of sleep disorders. Each power spectrum was assigned a probability between 0 and 2.5 (Odds Ratio Product; ORP) with 0 corresponding to a spectrum that was previously determined to occur only during sleep, and 2.5 to a spectrum that occurs only during wakefulness. Intermediate values reflect patterns that occur in both states to different extents and reflect different degrees of sleep stability. Average (\pm SD) ORP was calculated for each 30-second epoch and for the whole file.

Results: ORP file averages in stage awake ranged from 1.31-2.37 (1.91 \pm 0.33) among patients, reflecting different degrees of sleep intrusion within this stage. File averages were 0.13-1.97 (0.88 \pm 0.36) for stage-1 non-REM, 0.09-1.67 (0.56 \pm 0.29) for stage-2 non-REM, 0.07-0.84 (0.23 \pm 0.19) for slow-wave sleep and 0.12-1.76 (0.80 \pm 0.42) for REM sleep. ORP varied between different epochs of the same sleep stage in each patient and the extent of this variability (SD between epochs) ranged from 0.0 to 0.7 among patients.

Conclusion: The spectral pattern of the EEG varies widely during sleep and wakefulness both within and between patients with sleep disorders. Conventional sleep staging does not capture this variability. Quantitative assessment of the spectral pattern may provide additional information that reflects sleep quality and account for differences in the severity of sleep symptoms.

Support (If Any): YRT Ltd, Winnipeg, Canada. FMC Sleep Centre Development Fund.

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SHORT-EPOCH VISUAL SCORING OF POLYSOMNOGRAPHY

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Introduction: Few issues in sleep are as important as correctly quantifying and staging polysomnographic (PSG) recordings. AASM developed its 2007 scoring manual by consensus. Where there was insufficient evidence for change, the approach defaulted Rechtschaffen and Kales rules. Other sleep scoring methods may have advantages but have not been systematically evaluated. Here we report on our effort to improve the resolution of PSG scoring using a short epoch length (1 second) instead of the traditional 20 or 30 second epoch. This was intended to address the problem with the current method that frequently only a portion of the activity during an epoch actually represents activity characteristic of the scored stage for that epoch.

Methods: A set of sleep studies were scored by two highly-experienced Board Certified raters using current AASM rules. Three individuals re-scored these studies using 1 second epochs after discussing and agreeing upon means to score with this method. The findings and suggestions for improving 1 s epoch scoring are reported.

Results: Scoring in 1 s epochs decreased data lost to artifact. However, despite planning to score each epoch independent of prior or future epochs, this was not possible because: 1) visually differentiating low-amplitude, mixed-frequency EEG backgrounds (by sleep stages) consistently required repeated trials; 2) phenomenon such as Alpha activity mixed with high amplitude delta and sleep spindles required assessing the nature of the activity before or after the epoch; 3) Scoring of Stage R in patients with minimal EMG drop required considerable review of other epochs.

Conclusion: This attempt to pursue a different sleep scoring methodology identified a number of challenges that need to be overcome. Further work is needed to refine methods, assess reliability and validity and compare this method with traditional scoring. If successful, we will develop a scoring manual for short-epoch scoring.

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COMPUTER-ASSISTED AUTOMATED SCORING OF POLYSOMNOGRAMS: THE SOMNOLYZER PROJECT

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Introduction: Polysomnography (PSG) is the primary diagnostic test in sleep medicine. It is commonly utilized in assessing sleep and breathing disorders and relies on trained technicians to review the nocturnal recording. Manual scoring of a PSG, however, is a time-consuming and tedious process. To expedite the scoring of PSGs and cope with the burden of diagnostic testing, several computerized algorithms for automated scoring have been developed. The overarching goal of this study is to determine the validity of the Somnolyzer® scoring platform, an automated system for scoring PSGs.

Methods: The analysis sample comprised 97 sleep studies drawn from accredited sleep laboratories. Each PSG was manually scored by certified technologists at four distinct sleep laboratories and subjected to automated scoring by the Somnolyzer® system. The automated results were reviewed by a trained technician or physician. Agreement between manual and automated scoring was examined using bivariate scatter plots, Pearson's correlation coefficients, Bland-Altman analysis, gener-

alized mixed models, and concordance correlation coefficients. Sleep staging and scoring of disordered-breathing events was conducted using standard criteria.

Results: A high degree of agreement was noted between manual and automated scoring of the apnea-hypopnea index (AHI). The average correlation for the AHI across the four clinical sites was 0.92 (95% CI: 0.90-0.93). Similarly, the average correlation between the manual and automated derived values of AHI was 0.93 (95% CI: 0.91-0.96). Thus, inter-scorer correlation between the manually scored results was no different than that derived from manual and automated scoring. Irrespective of whether the AHI values from manual scoring were compared between technologists or to the values from automated scoring, a high degree of agreement between AHI was observed. Substantial concordance in arousal index, total sleep time, and sleep efficiency between manual and automated scoring was observed. In contrast, differences were noted between automated and manually scored percentages of sleep stages N1, N2, and N3.

Conclusion: Automated analysis using the Somnolyzer® platform provides results that are comparable to that obtained by manual scoring for the most commonly used metrics in sleep medicine. While some differences exist between manual versus automated scoring of particular sleep stages, the level of agreement between manual and automated scoring is not significantly different than that between any two human scorers. Thus, in light of the burden associated with visual scoring, automated systems, such as the Somnolyzer® platform, provide a viable complement in the armamentarium in sleep medicine.

Support (If Any): Philips Respironics; NIH Grant HL075078.

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ASSESSING THE REPRODUCIBILITY OF A STANDARDIZED ACTIGRAPHY SCORING ALGORITHM IN A HISPANIC POPULATION

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Introduction: Actigraphy is increasingly utilized to measure sleep duration, quality, and timing. While actigraphy is considered objective, the process of setting the rest intervals in order to calculate sleep variables is subjective. We sought to evaluate the intra- and inter-scorer reliability of 9 sleep variables measured with actigraphy using a standardized algorithm for setting rest intervals in the Sueño ancillary study to the Hispanic Community Health Study/Study of Latinos (HCHS/SOL).

Methods: The Sueño ancillary study recruited HCHS/SOL participants ages 18-64 across four sites to undergo 7 days of actigraphy using the Actiwatch Spectrum device accompanied by sleep diaries completed each morning upon awakening. A random sample of 50 studies was re-scored twice by each one of two scorers. Rest intervals were set by scorers using a standardized hierarchical approach based on event marker, diary, light, and activity data in order of importance. The Actiware 5.59 algorithm using 5 immobile minutes for sleep onset, 0 immobile minutes for sleep offset, and a wake threshold of 40, was applied to each study to generate values for: mean nightly sleep duration, total sleep duration, napping time, sleep efficiency, sleep fragmentation index, sleep onset time, sleep midpoint time, standard deviation of sleep duration, and standard deviation of sleep midpoint. Intra-scorer and inter-scorer variability was assessed with intraclass correlation coefficients (ICCs) estimated using random effects models.

Results: Intra-scorer ICCs across all 9 measures were high ranging from 0.960 to 0.997. Similarly, inter-scorer ICCs were high also ranging from 0.960 to 0.997. Using Bland-Altman plots, no systematic disagreement in scoring was identified.

Conclusion: With use of a standardized algorithm to set rest intervals, scoring of actigraphy for the purpose of generating a wide array of sleep variables is highly reproducible.

Support (If Any): NIH HL098297.

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CORRELATION BETWEEN SLEEP DURATION MEASURED BY ACTIGRAPHY: POLYSOMNOGRAPHY AND PITTSBURGH SLEEP QUALITY INDEX QUESTIONNAIRE

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Introduction: Sleep shortage has been associated with metabolic and neurologic disturbances including memory loss and metabolic syndrome. The different studies used a variety of objective and subjective methods to assess sleep duration. In most cases the samples were not representative of general population. This approach has led to inconsistent results. The present study was aimed to compare the measurements of sleep duration by actigraphy, PSG (polysomnography) and the SQI questionnaire (Pittsburgh sleep quality index questionnaire) to assess the comparability of these methods.

Methods: A population-based survey adopting a probabilistic three-stage cluster sample of Sao Paulo was used to represent the population according to gender and age (20-80 years). This sample included 396 individuals who underwent full PSG, actigraphy answered to the SQI questionnaire. Pearson product-moment correlation was used to measure the relationships between these methods.

Results: Sleep duration measured by actigraphy correlated significantly with measurements by PSG ($R = 0.13$ $p = 0.008$) and SQI questionnaire ($R = 0.36$ $p < 0.001$). Sleep duration measured by PSG did not correlate significantly with SQI questionnaire ($R = 0.03$ $p = 0.54$). Considering the influence of AHI (apnea-hypopnea index), if $AHI < 5$, sleep duration measured by actigraphy correlated significantly with measurements by PSG ($R = 0.13$ $p = 0.04$) and SQI questionnaire ($R = 0.39$ $p < 0.001$). If $AHI \geq 5$, sleep duration measured by actigraphy correlated significantly with measurements by SQI questionnaire ($R = 0.26$ $p = 0.031$). Considering the influence of gender, sleep duration of women measured by actigraphy correlated significantly with PSG ($R = 0.14$ $p = 0.02$) and SQI questionnaire ($R = 0.32$ $p < 0.001$), while sleep duration of men measured by actigraphy correlated significantly with measurements by SQI questionnaire ($R = 0.40$ $p < 0.001$).

Conclusion: This study shows that the measurement of sleep duration by actigraphy correlates with measurements by PSG and SQI questionnaire. The stronger correlation was between actigraphy and SQI questionnaire. There was no significant correlation between PSG and SQI questionnaire. Correlations were influenced by AHI and gender. We speculate that the stronger correlation between actigraphy and SQI questionnaire may reflect the fact that both methods represent sleep duration in normal environmental conditions over the course of several days, while PSG represents single a night's sleep duration in laboratory conditions. Future studies using more advanced techniques would determine the accuracy of these methods.

Support (If Any): FAPESP/CEPID, AFIP.

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ASSESSMENT OF TREATMENT OUTCOMES WITH VIBRO-TACTILE POSITION THERAPY

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Introduction: This study is an initial evaluation of a neck-worn device for the treatment of positional obstructive sleep apnea (OSA).

Methods: Twenty patients underwent baseline polysomnography (PSG), four-weeks with neck-worn delivery of supine-dependent vibro-tactile feedback, and a treatment-delivered follow-up PSG. Video and body position were combined to determine PSG supine time. Subjective measures included Epworth Sleepiness Score (ESS), Functional Outcomes of Sleep Questionnaire (FOSQ), Insomnia Severity Index (ISI), Patient Health Questionnaire (PHQ9), and Profile in Moods State (POMS). Utilization was tracked weekly with internet-based compliance monitoring. Inclusion required a pre-enrollment ESS ≥ 5 , overall apnea-hypopnea index (AHI) ≥ 10 , and overall/non-supine AHI ratio ≥ 1.5 .

Results: At baseline, 35% of subjects had overall severe, 30% moderate, and 35% mild OSA. After four-weeks of therapy, a $> 50\%$ decrease in overall AHI was observed in 85% of cases (17 of 20). Significant decreases in overall AHI (26.4 ± 16.2 vs. 8.6 ± 8.8 ; $p < .00001$), supine AHI (45.0 ± 24.9 vs. 4.7 ± 12.9 ; $p < 0.0001$), and percent time supine (47.8 ± 12.6 vs. 2.7 ± 7.3 ; $p < 0.00001$) were recorded. A 50% reduction in overall AHI was recorded in the 3 cases with retest supine time $> 1\%$. Significant improvements in sleep architecture (% Stage-N1: 40.7 ± 15.2 vs. 25.4 ± 11.4 ; $p < 0.001$) and continuity (respiratory arousal index: 28.3 ± 16.5 vs. 13.9 ± 13.0 , $p < 0.01$) were observed. Based on a changes greater-than 3, POMS/overall and POMS/fatigue improved in 65% and 60% of cases, FOSQ/overall, FOSQ/activity, and insomnia severity improved in 45% of subjects, and daytime somnolence (ESS) and depression (PHQ9) improved in 40% of cases. An increase non-supine AHI at retest contributed to two of three cases who did not achieve $\geq 50\%$ reduction in overall AHI; both showed improvements in ESS, FOSQ, and ISI. One patient was dropped due to administrative non-compliance, all others wore the device for during their regular bed time each night for four weeks.

Conclusion: Vibro-tactile feedback shows promise as a treatment for those with positional sleep apnea.

1040

WAVELET FEATURE EXTRACTION FOR PHASIC MUSCLE ACTIVITY IN HUMAN SLEEP

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Introduction: Phasic muscle activity in the human NPSG may be an important indicator of incipient neurodegenerative diseases, however, manual quantification is time consuming. Attempts to automate EMG have focused largely on spectral analyses limited to the amplitude domain. Wavelets (WTs) represent an attractive approach to quantification of EMG activity in human sleep, because they incorporate both amplitude and time/frequency domains. We describe here validation of such an approach incorporating different dimensionality reduction techniques.

Methods: We examined 12 separate artifact-free leg (6 subjects, L/R separately) EMG segments, each selected to represent roughly equal amounts of REM and NREM. Visual validation of 1 sec intervals (131,238 secs) for presence/absence of phasic activity preceded feature extraction/dimensionality reduction components. Symlet (SYM) and Daubechies (DAU) wavelet families were used for feature extraction, followed by both principal components analysis (PCA) and frequency/variable selection (FVS) algorithms for dimensionality reduction using non-overlapping 1 sec moving windows. All pt/leg segments were analyzed separately. A linear classifier was used to determine True Positive/True Negative %'s comparing automated results to visual labeling.

Results: Results indicated robust models with 12 subject/leg segments (each encompassing all possible SYM/DAU -PCA/FVS pairs; total N = 48) exceeding TN's of 92%. For TP's a single leg segment from 1 subject fell in 75-80% range (similar for all SYM/DAU - PCA/FVS pairs, with all others > 90%).

Conclusion: These data suggest WT approaches for phasic EMG quantification are minimally affected by the selected feature extraction methods and data reduction techniques discussed here. The single leg segment with the lower TN value was not conspicuous for artifacts, however, establishment of an artifact library (e.g., ballistocardiogram, 60 Hz, impedances > 10K ohms, etc) would aid in understanding to what extent a turn-key EMG quantification system could be applied routinely to the human sleep EMG.

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AUTOMATIC ANALYSIS OF A NON-CONTACT SENSOR SIGNAL EFFECTIVELY DETECTS THE PRESENCE OF OBSTRUCTIVE SLEEPAPNEA

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Introduction: Sleep apnea is a prevalent condition associated with significant comorbidity. Polysomnography (PSG) provides high quality data limited to a single night requiring supervision by a technologist and multiple obtrusive sensors which can interfere with comfort and sleep. This along with high cost of attended testing increased demand for home apnea tests. Home apnea tests depend on patient application and maintenance of leads resulting in frequent data loss. Home tests can be done on serial nights, but data storage and patient maintenance of signal integrity are significant limitations. We previously demonstrated non-contact apnea detection without application of sensors onto patients. This has great potential for long-term serial night respiratory analysis without limitations of data storage, battery life, or patient dependent maintenance of signal integrity. Large data sets generated by long-term unattended monitoring require development of automatic assessment of the non-contact sensor signals.

Methods: Load cells were applied to beds in two sleep labs and concurrent load cell and PSG data were collected for 104 patients. PSG data was scored according to AASM guidelines. Disordered breathing index (DBI) values were calculated for each patient using only the load cell data by iterative training and testing of algorithms using a leave one out method.

Results: The DBI predicted the presence of sleep apnea with high sensitivity and specificity for AHI cutoff values of 5, 15, and 30. Area under the curve values from receiver operating characteristic analysis for the respective AHI cutoff values were 0.87, 0.92, and 0.91. The average difference between AHI and DBI was not significant ($t_{103} = 0.0035, p = 0.9972$).

Conclusion: Automatic detection of data from a non-contact sensor effectively detected the presence or absence of obstructive sleep apnea. This has great potential for long-term home apnea testing and long-term monitoring of treatment at home without applying sensors onto patients.

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FIELD TEST OF A MODEL OF THE HUMAN CIRCADIAN OSCILLATOR

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Introduction: Retinal light exposures synchronize circadian rhythms to local environment. Kronauer and colleagues proposed a model of the human circadian oscillator that allows for quantitative predictions of circadian phase changes resulting from light exposure. The model consists of a light-stimulus phototransduction process (L) driving an oscillator-based pacemaker process (P). The process L was modified to include new knowledge of human circadian phototransduction. Parameters of the process P were revised based on data from field studies where light exposures and circadian phase changes were measured.

Methods: Data from three independent field studies were used to assess model predictions. In every study, dim light melatonin onset (DLMO) was measured after a baseline week and after an intervention week where subjects were placed on an advanced (1.5 h) sleep/wake schedule and received specific light treatments designed to either advance or delay circadian phase. Circadian phase change from baseline to post-intervention week (Δ DLMO) was assessed. Every subject wore a Daysimeter, a calibrated light and activity recording device. Model predictions of phase change based on continuously measured (24 hr/day) light exposure were compared to measured phase changes (Δ DLMO). Instead of photopic illuminance (lux), circadian stimulus (CS), a transform of circadian illuminance (CLA), was used as input to the Process L. Two parameters in the process P were adjusted (k and q) and a time-dependent sensitivity modulation factor was removed.

Results: The correlation between Δ DLMO and predicted phase changes calculated from the Daysimeter data and the modified Kronauer model was statistically significant ($R^2 = 0.66, p < 0.0001$) with a prediction uncertainty of 1.75 hours (95% confidence).

Conclusion: Daysimeter light data and the modified Kronauer model provide first-order predictions of circadian phase change, serving as a foundation for light treatments of individuals with circadian sleep disorders.

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TEST-RETEST RELIABILITY OF THE LOUGHBOROUGH OCCUPATIONAL IMPACT OF SLEEP SCALE (LOISS)

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Introduction: This analysis was conducted to assess test-retest reliability and psychometric properties of the Loughborough Occupational Impact of Sleep Scale (LOISS), a 19 item questionnaire designed to capture sleep related occupational impairment.

Methods: The test-retest interval was 2 weeks. Participants completed the LOISS and the Pittsburgh Sleep Quality Index (PSQI) at Time 1 (T1) and Time 2 (T2). Test-retest reliability was analysed using Pearson correlation analysis. Given that T1-T2 change in LOISS scores would

be expected to vary as a function of change in sleep quality, multiple regression analysis was conducted to assess if LOISS scores at T1 predicted LOISS at T2 after adjusting for the degree of sleep quality change (measured by PSQI).

Results: A convenience sample of 43 working adults (63% female, mean age = 35.14 SD = 13.13) were recruited using public noticeboards and posters in Loughborough, UK. LOISS showed strong internal reliability at T1 ($\alpha = 0.95$) and T2 ($\alpha = 0.94$). No significant differences were present for LOISS scores at T1 and T2, with T1 and T2 values showing a positive and significant correlation ($r = 0.77$, $r^2 = 0.59$, $p < 0.001$, two-tailed). PSQI scores at T1 and T2 were significantly different ($t(42) = 2.01$, $p = 0.05$) indicating an improvement in sleep quality during the test interval. Regression analysis showed that LOISS T1 scores were a significant predictor of LOISS at T2 whilst adjusting for changes in sleep quality ($B = 0.76$, $t = 3.01$, $p < 0.01$). PSQI change score was not a significant independent predictor of LOISS at T2.

Conclusion: Controlling for variations in sleep quality across the test interval, LOISS scores showed high and significant test-retest reliability.

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PSYCHOMETRIC PROPERTIES OF THE HYPNOTIC CARVING SCALE: A PRELIMINARY REPORT

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Introduction: It is common for patients with chronic insomnia to use hypnotics for a prolonged period of time and find it difficult to discontinue using them. However, there are only limited numbers of studies addressing this phenomenon. Based on the theoretical model of addiction, the present study aims at developing the Hypnotic Craving Scale (HCS), a self-rating scale to measure the extent of hypnotics craving.

Methods: An initial version of the HCS contained 37 that were developed by modifying items from the Benzodiazepine Craving Questionnaire and the Questionnaire of Smoking Urges, and created by interviewing hypnotic users and consulting experts in the field. The HCS was then administered to 136 current hypnotic users.

Results: Exploratory factor analyses indicated that a three-factor solution best describes the item structure, which were: (1) desire to use hypnotics; (2) lack of control over hypnotics use, and (3) relief from negative subjective experiences. Seventy items with significant loadings are selected for the final scale, which can account for 72.96% of the total variance. The Cronbach's alpha coefficients of the three subscales range from .75 to .95.

Conclusion: The HCS was shown to have good internal consistency reliability and construct validity. While these results are promising, future studies are required to further explore its clinical utility.

Support (If Any): National Science Council, Taiwan.

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IS THE EPWORTH SLEEPINESS SCALE THE APPROPRIATE INSTRUMENT TO ASSESS SLEEPINESS IN THE OBESE PATIENT?

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Introduction: Sleepiness is a common symptom of obstructive sleep apnea syndrome (OSA). The Epworth Sleepiness Scale (ESS) has been used widely as a clinical tool to document sleepiness in OSA. ESS is easy to use, making it suitable for predicting severe OSA, and to evaluate effective CPAP treatment. Recently, several issues have been raised regarding measuring sleepiness by ESS. The objective of this study was to explore the diagnostic test characteristics of ESS against the Multiple Sleep Latency Test (MSLT) in obese patients with suspected OSA.

Methods: Patients were recruited from the Sleep Clinic at INCMNSZ in Mexico City, referred by suspected OSA for snoring, and/or respiratory pauses symptoms. The patients were included, if they gave the informed consent and to have BMI ≥ 30 kg/m², non drug and alcohol addictions, hypothyroidism, and Depression diagnosis, nor medication that may affect sleep or if they worked night shift, or if they provided night-time caregiving. One hundred ninety-three obese patients (119 W, 74 M), with similar mean age = 39.4 ± 12 y/o, and mean BMI 48.3 ± 10 kg/m² ($W = 48.97 \pm 8.8$, $M = 47.2 \pm 12.8$ Kg/m²) went to spend two consecutive nights in the Sleep Clinic for polysomnography (PSG), followed by the MSLT. The ESS was applied the second PSG night. A MSLT mean score ≤ 8 min was considered positive diagnosis for sleepiness (Sleepiness-Group n = 152, Non-Sleepiness-Group n = 41). An ESS score > 10 was considered positive for sleepiness. We calculated the sensitivity, specificity, FPR and FNR for women (W) and men (M).

Results: The 78.8% patients (W 45.6%; M 33.2%) were diagnosed as sleepy by MSLT, mean MSLT score 3.8 ± 2.07 min ($W 3.7 \pm 1.9$ min; $M 3.9 \pm 2.3$ min). Patients not diagnosed as sleepy had mean MSLT = 12.4 ± 2.8 min ($W 12.0 \pm 2.8$; $M 13.6 \pm 2.7$). The ESS showed 36.8% patients were sleepy (W 24.9; M 11.9%), mean ESS 14.52 ± 3.38 ($W 14.52 \pm 3.51$; $M 14.52 \pm 3.16$). The ESS showed Sensitivity = 36.8, Specificity = 63.4, FPR (1-Specificity) = 78.9, FNR (1-Sensitivity) = 21.3. The ESS diagnostic test's discriminatory power was: Women Sensitivity 31.9, Specificity 67.7, FPR (1-Specificity) = 79.2, FNR (1-Sensitivity) = 29.6, whereas Men Sensitivity 28.12, Specificity 50.0, FPR (1-Specificity) = 78.3, FNR (1-Sensitivity) = 9.8.

Conclusion: According to MSLT, sleepiness is highly prevalent (78.8%) in obese patients. The ESS identifies only the 36.8% of sleepy patients. The Epworth Scale in obese patients is not a good instrument to determine whether a patient is or is not sleepy.

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THE PITTSBURGH SLEEP QUALITY INDEX: VALIDATION OF THE URDU TRANSLATION

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Introduction: Pittsburgh Sleep Quality Index (PSQI) is a standardized self-administered instrument for measuring sleep quality. Our aim was to translate and validate the PSQI into the Urdu language.

Methods: The PSQI was translated into Urdu following standard guidelines. The final Urdu version (PSQI-U) was administered to 200 healthy volunteers comprising medical students, nursing staff and doctors. After 4 weeks of administration of the PSQI-U, 100 bilingual subjects were administered PSQI-English (E), and the remaining 100 subjects were administered PSQI-U again for assessment of linguistic interchangeability and test-retest reliability respectively.

Results: One hundred eighty-five (185) participants completed the PSQI-U at baseline. The Cronbach alpha for PSQI-U was 0.56. Scores on individual components of the PSQI-U and composite scores were all highly correlated with each other (all p values < 0.01). Composite scores for PSQI-U at baseline and PSQI-E at 4-week interval were also highly correlated with each other (Spearman correlation coefficient 0.74, P value < 0.01) indicating good linguistic interchangeability. Composite scores for PSQI-U at baseline and at 4-week interval were positively correlated with each other (Spearman correlation coefficient 0.70, P value < 0.01) indicating good test-retest reliability.

Conclusion: The results of our study demonstrate that the PSQI-U is a valid and reliable instrument for the assessment of sleep quality. It shows good linguistic interchangeability and test-retest reliability in comparison to the original English version when applied to individuals who speak the Urdu language. The PSQI-U can be a tool either for clinical management or research.

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REPRODUCIBILITY OF THE EPWORTH SLEEPINESS SCALE IN THE CLINICAL SETTING

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Introduction: Due to an increasing demand on diagnostic services for sleep disorders, especially polysomnography (PSG), a rational strategy to manage the waiting list is warranted. The Epworth Sleepiness Scale (ESS) has been widely used as a subjective measure of sleepiness. It has the potential to be a clinical tool to help determine the priority for testing. Our aim is to evaluate the reproducibility of the ESS in the clinical setting.

Methods: We conducted a retrospective review of PSGs performed at the University of Alberta Sleep Disorders Laboratory (SDL) from April to September of 2013. Clinical information including the ESS score provided by the referring physician in the requisition form (ESS-R) and the ESS score obtained in the SDL (ESS-L) were collected and analyzed to evaluate reproducibility.

Results: Of the 878 cases reviewed, 361 had both ESS-R and ESS-L recorded. Of these 361 cases, 194 were males (54 %) and 167 were females (46 %). The mean age was 54.19 ± 14.02 yrs (SD). Mean BMI was 38.40 ± 10.96 . The diagnoses included sleep disordered breathing and non-sleep disordered breathing sleep disorders. ESS-R was 11.2 ± 5.34 and ESS-L was 9.9 ± 5.4 (mean \pm SD). These sets were statistically different (student's paired T-test; $p < 0.0001$). The correlation coefficient (R^2) was 0.405. ESS-R was greater than ESS-L in 202 cases (55.9%),

equal to ESS-L in 36 (10.0 %) and less than ESS-L in 123 (34.1%). A clinically significant difference between ESS-R and ESS-L of 4 or more was seen in 136 (37.7%).

Conclusion: The ESS score provided by the referral physician correlates poorly with the ESS score obtained at the laboratory. This raises a concern regarding the reproducibility of the ESS in the clinical setting and its reliability as a tool for determining the priority for PSG testing.

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SUBJECTIVE ANALOGUE SLEEPINESS SCALE AS A PREDICTOR OF ABNORMAL MULTIPLE SLEEP LATENCY TEST

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Introduction: Daytime hypersomnia is a pervasive medical problem, with many American adults reporting sleepiness so severe it frequently interferes with their everyday activities. Clinical assessment of hypersomnia is primarily achieved using the Multiple Sleep Latency Test (MSLT), in which sleep latency is measured in five daytime nap opportunities. Physicians use subjective measures to pre-screen patients for MSLTs. The Epworth Sleepiness Scale (ESS), the most popular validated subjective measure of sleepiness, asks patients how likely they are to fall asleep in multiple scenarios. However, little research has examined whether analogue scales asking patients how sleepy they feel on a scale of 0-5 are predictive of quantitatively determined sleepiness. This research explores the subsection of pathologically sleepy patients that the ESS overlooks whose sleepiness would have been detected using an analogue scale.

Methods: Participants were new patients in a sleep lab pre-selected for an MSLT through high ESS, high analogue score, referral for sleepiness, or falling asleep while driving. Participants completed both ESS and analogue scales prior to overnight polysomnography followed by an MSLT. ESS and analogue scores were correlated with average sleep latency on the MSLT.

Results: Of 106 clinically sleepy patients (MSLT < 10 minutes), the populations detected by ESS (ESS > 11, 77 patients, 73%) and analogue (score > 3, 73 patients, 68%) were overlapping but distinct. In total, 22 patients (20.8%) could be detected only by analogue score.

Conclusion: If doctors rely exclusively on the ESS for the evaluation of sleepiness and MSLT screening, they risk overlooking a significant portion of the clinically sleepy population. This may be due to variations in the will to stay awake, differing subjective experiences of sleepiness, or an array of other factors. Regardless of the underlying cause of this discrepancy, doctors should look at analogue scores in conjunction with ESS when screening patients for further evaluation of hypersomnia.

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ARE SMARTPHONE SLEEP APPS ACCURATE ENOUGH FOR CLINICAL USE?

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Introduction: Several inexpensive, readily available smartphone apps monitor sleep, but their uncertain accuracy limits their potential clinical use. We therefore performed this pilot study to determine the accuracy of the sleep parameters reported by the Sleep Time app (Azumio, Inc.) for iPhones.

Methods: Twelve healthy volunteers with no known sleep disorders were enrolled. Subjects were 75% male, mean age was 39.8 years (standard deviation [SD] \pm 11.4), and mean body mass index was 24.7 kg/square meter (SD \pm 2.55). All subjects underwent simultaneous in-laboratory polysomnography (PSG) and app usage. Mean apnea-hypopnea index was 5.3/hr (SD \pm 5.9), mean periodic limb movement index was 6.8/hr (SD \pm 12.4), and mean arousal index was 7.9/hr (SD \pm 6.1). We compared absolute parameters reported by the app with PSG data (sleep efficiency, percentages of light sleep [N1 and N2 for PSG] and deep sleep [N3 and REM for PSG]) and also compared 15-minute app and PSG epochs for sleep-wake correlation. Pearson correlation coefficient (r) and diagnostic parameters (sensitivity [app and PSG both sleep], specificity [app and PSG both wake], positive predictive value [PPV], negative predictive value [NPV] and overall accuracy [percentage of app epochs correlating with PSG epochs]) were calculated using Prism® software. Because the app and PSG sleep latencies were non-normally distributed, we used Spearman's rank correlation measure (ρ) for analysis.

Results: There was no correlation between app and PSG sleep efficiency ($r = -0.28$, $p = 0.375$), light sleep percentage ($r = -0.09$, $p = 0.780$) or deep sleep percentage ($r = 0.08$, $p = 0.809$). Similarly, there was no correlation between app and PSG sleep latency ($p = 0.20$, $p = 0.528$). Sensitivity was 44.8% (95% confidence interval [CI] 39.0-50.6%), specificity was 51.9% (32.0-71.3 %), PPV was 91.1% (85.3-95.2%) and NPV was 7.9% (4.4-12.8%). Overall accuracy was 45.5%.

Conclusion: This pilot study shows that the Sleep Time app (Azumio, Inc.) for iPhones is insufficiently accurate for use in clinical sleep medicine.

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HOW FITNESS HEART RATE BELTS AND MOBILE PHONES MAY BE USED TO SCREEN FOR SLEEP DISORDERS

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Introduction: Autonomic function fluctuates during day and night according to physical activity level, cognitive and emotional tasks, and sleep wake states. Heart rate variability (HRV) analysis has been widely used as a reliable noninvasive measure of autonomic function. Previous studies indicate that the balance between the sympathetic and the parasympathetic activity (ABI) is lowest during slow wave sleep. We suggest that when no complete PSG is available, the minimal ABI (min-ABI) during the first part of the night may serve to define normal population ABI distribution, and serve as a screening tool for sleep disorders.

Methods: People who are interested in their sleep may use an iPhone application that records instantaneous heart rate during the night while connected to a smart fitness belt. The information is uploaded for further analysis in the cloud and users get information regarding sleep structure, efficiency, and continuity based on HRV analysis. Many use the application for recurring nights. During July to November 2013, 10 users recorded at least ten nights almost consecutively, and two of them recorded a second 10-night sequence after a couple of months. ABI has been calculated for all 10-night sequences for the whole night, different sleep stages, and the minimal value for 10 minutes (minABI) during the first 2 hours of sleep. An arousal index has been also calculated based on HRV in the time domain.

Results: Mean ABI was highest with a large standard deviation during REM and lowest and with low standard deviation (STD) during REM, in all 10 users. minABI presented lowest STD also: In 8 users the range was 0.46 (STD = 0.26) to 1.8 (STD = 0.91). The two users who recorded two sequences had significantly higher values in both sequence: 10 (STD = 5.5) in one and 3.5 (STD = 1.3) for the second. The arousal

index for those was 31.4 (STD = 3.6) for the first and 26.3 (STD = 3.8); all users with minABI less than one had arousal indexes less than 10.

Conclusion: The results indicate that minimal values of ABI during the first part of the night are a candidate for setting normal baseline values of the autonomic balance. The fact that people who do not reach parasympathetic predominance during the first part of the night have also a higher autonomic arousal index indicates that this measure can be a good candidate to screen for sleep disorders.

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PATIENT VERIFICATION DURING HOME SLEEP TESTING

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Introduction: A new patient verification sensor, IDcheck™, was developed to make sure the data from a home test is from the patient of record. The advantages of home sleep testing (HST) include patient privacy and comfort, relief for overloaded/overbooked sleep labs, and cost savings. HST, however, lacks proof that the recorded data is actually from the prescribed patient. Some patient verification techniques, also referred to as Chain of Custody, exist; however, they include wrist or neck shackles that are too conspicuous and obtrusive to the patient's daily activities. This new sensor is simple to place on the body, single use, and is worn under a shirt discretely.

Methods: The new sensor was designed to adhere to the skin under a shirt and be connected to the device while sleeping. The single use adhesive of the sensor cannot be reapplied or reused. The sensor was tested for lasting at least 24 hours, maximum wear duration, evidence of tampering, and reliable signal quality.

Results: The sensor was found to maintain adhesion for more than three days, including multiple showers and exercise sessions during that time. In no case did the sensor fail before it was intentionally removed after at least 24 hours of wear. The sensor was also found to lose its adhesive properties if intentionally detached from the skin, thus confirming its single use advantage. Excellent signal reliability was recorded throughout the night.

Conclusion: A new easy to use sensor was developed and tested successfully for HST applications where patient verification is needed. The sensor was also appreciated for its non-conspicuous and unobtrusive form factor that allowed patients to resume daily activities without visible restraints placed around the wrists or necks.

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REASONS FOR INTER-RATER VARIABILITY IN SLEEP SCORING OF POLYSOMNOGRAPHY RECORDS

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Introduction: Inter-rater scoring variability limits the use of polysomnography (PSG). The reasons for differences between scorers have not been systematically investigated. Our objective was to identify the predominant reasons for this variability.

Methods: Fifty-six PSG records were scored by two experienced technologists (A, B) from two sleep centres (Manual-1). Their scoring was reviewed by a more senior technologist who noted systematic errors in applying the AASM guidelines. The two technologists edited their original scoring (Manual-2) based on this feedback. The PSGs were also scored by an automatic system (Michele Sleep Scoring) (Auto) and Auto was edited by the same two scorers. Epoch-by-epoch % agreement was calculated for different comparisons using 5-stage sleep scoring.

Results: There was an average 728 epochs per PSG (total = 40792 epochs). Agreement between scorers A and B for Manual-1 was 79%.

Agreement between scorers did not improve in Manual-2 (78%) despite 32 (scorer A) and 60 (scorer B) edits/PSG. Thus, instructions from a third party had little impact. Agreement between unedited Auto and Manual-2 was 76% for both scorers. Scorers A and B edited 66 and 114 epochs, respectively, per PSG. However, only 33 epochs/PSG (5% of epochs) were changed by both scorers to the same stage, thereby likely representing true errors by Auto. Of an average 154 epochs/PSG in which Auto differed from manual scoring, scorer A left 109 and scorer B left 53 unchanged. This suggests that many epochs could be scored as either of two stages, with the inter-rater difference resulting from different random selection by the scorers. Despite all these edits, the two scorers continued to disagree in 15% of epochs (final % agreement = 85%).

Conclusion: Inter-rater variability is in equal measure due to scorer bias and the presence of epochs that the scorer is comfortable assigning to either one of two scores.

Support (If Any): YRT Ltd, Winnipeg, Canada. FMC Sleep Centre Development Fund.

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SLEEP SCORING USING A LIMITED MONTAGE: FOREHEAD EEG AND CHIN EMG

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Introduction: Sleep scoring performed using the 10-20 system is usually performed in the laboratory with a trained technician applying electrodes. Home monitoring of sleep is made easier by self-application of limited number of electrodes positioned only on the face. We evaluated moving the F4 lead to the forehead and scoring sleep using this and a bipolar chin EMG only. This study examines agreement for sleep scoring using full polysomnography compared to scoring using these modified leads.

Methods: 21 subjects (11M/10F) who were undergoing full in-laboratory polysomnography for evaluation of obstructive sleep apnea had one frontal lead moved to the forehead. Conventional sleep scoring from the unmodified F4, C4, EOG and EMG was performed by an experienced sleep technologist using AASM rules. Limited monitoring (LM) sleep scoring was done independently by 2 scorers while viewing only the modified F4 and chin EMG. For each study, epoch-by-epoch agreement was tabulated (i) between each scorer's LM scoring and full PSG AASM scoring and (ii) between scorers LM scoring.

Results: 17,786 epochs were scored (669-990 epochs/subject). The mean agreement between LM and full PSG was 78% (range 59-88%/subject) for scorer 1 and 80% (range 66-92%/subject) for scorer 2. For both scorers agreement between LM and full PSG for epochs scored as sleep or wake scoring only was 93% (range 75-98%) and for REM vs NREM was 93% (83-99%). For LM alone, inter-scorer agreement was 78% (range 63-88%), 91% for sleep-wake (range 76-97%) and 88% for REM vs NREM (range 78-90%).

Conclusion: Repositioning of F4 EEG to the forehead and scoring from this and chin EMG resulted in excellent discrimination of sleep from wake and REM from NREM sleep. Inter-scorer LM epoch-by-epoch agreement across all stages is similar to that seen between scorers using full polysomnography and suggests its utility in the home.

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AUTOMATED SLEEP STAGE CLASSIFICATION USING THE MAXIMUM ENTROPY METHOD

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Introduction: Visual scoring of sleep stages is standard method of polysomnographic analysis, even though it is known taking time for acquiring scoring technique and scoring itself are disadvantage on visual scoring. It is needed for automatic scoring to detect physiological variation along with sleep process. In this study, a time series data analysis technique that combines a non-linear least square method with maximum entropy method was assessed of sleep EEG. We evaluated epoch agreement of sleep stages assessed by automated technique and visual scoring.

Methods: Twenty nine polysomnographic data were collected from normal volunteers during April in 2010 to October in 2011 recorded at Ota sleep disorders center. EEG (F3-A2, F4-A1, C3-A2, C4-A1, O1-A2, O2-A1), EOG (ROC, LOC), chin-EMG, were contained on standard polysomnography. Firstly sleep stages had been scored by visual based on R & K rule. Then, an average slope of exponential spectrum of a 30 seconds window from six EEG channels was calculated of all dates using MemCalc/SyUn. Sleep stages were classified based on the threshold of an average slope of each data.

Results: Average slopes of all data were ranged from -0.40 to -0.14. An average slope reduced regularly ordered to Stage W (-0.06), StageR (-0.07), Stage1 (-0.08), Stage2 (-0.09), Stage3 (-0.10), Stage4 (-0.11). Average epoch agreement of sleep stages of all data between automated and visual was 87%.

Conclusion: It is suggested that an average slope of exponential spectrum calculated by maximum entropy method could classify sleep stages.

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RESPIRATION DYNAMICS: A NOVEL APPROACH TO SLEEP-WAKE STAGE ARCHITECTURE

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Introduction: Thoraco-abdominal movement signals in polysomnography recordings are mainly used for categorizing breathing pauses. However, respiration dynamics depend to some extent on sleep-wake stages defined by electroencephalography. We tested the hypothesis that sleep-wake stages can be classified using respiration signals alone.

Methods: We screened clinical polysomnography records with apnea-hypopnea indices and periodic limb movement indices under 10. We selected uninterrupted three-minute windows of low-artifact abdominal respiratory effort belt signals. These windows were taken from technician-scored stages of wake, N2, N3, or REM sleep. We excluded segments with significant movement artifact, limb movement, or sleep disordered breathing events. Time-frequency spectrograms were estimated for the respiratory data, spanning the frequency range zero to 0.4 Hz. We trained a Naïve Bayes Classifier using feature vectors constructed from a combination of mean and variance measurements extracted from consecutive columns of the spectrogram matrices. A 10-fold cross validation was implemented to evaluate the classifier. Each sleep-wake stage consisted of at least 100 instances.

Results: Binary classification of wake versus any sleep stage yielded sensitivity and specificity of 79% and 89%. Binary classification of REM versus any-NREM (N2 or N3) yielded sensitivity and specificity of 74% and 80%. Three class distinctions showed a sensitivity for wake of 72%, with the most frequent mis-classification as REM sleep.

REM sensitivity was 64%, and the most frequent mis-classification was any-NREM, while sensitivity for any-NREM was 78%, and the most frequent mis-classification was REM. Binary distinction of N2 and N3 was poor, as scored N2 was more likely to be classified as N3 by the algorithm.

Conclusion: Respiration movement dynamics contain sleep-wake stage-specific information. The wake versus any sleep distinction shows the greatest promise, while distinguishing N2 and N3 was the most challenging. Supervised and unsupervised machine learning techniques hold promise for understanding sleep physiology through alternative sleep architecture analytics. The results have potential implications for quantifying sleep in limited channel portable testing devices.

Support (If Any): Department of Neurology, Massachusetts General Hospital; Young Clinician Award, Center for Integration of Medicine and Innovative Technology.

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AUTOMATIC SCORING OF AROUSAL INTENSITY BASED ON TIME AND FREQUENCY CHARACTERISTICS OF THE ELECTROENCEPHALOGRAM

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Introduction: The visual appearance of cortical arousals varies widely from those that barely meet scoring criteria to very intense arousals with extensive changes on the electroencephalogram (EEG). Conventional manual scoring of sleep measures the frequency of arousals but does not quantify their intensity. We hypothesized that the visual intensity of arousals provides additional information about their physiological consequences. The objective of this study was to develop an automatic algorithm to scale arousal intensity and to determine whether the arousal scale correlates with the associated increase in heart rate (HR).

Methods: Polysomnography (PSG) records of 20 patients with a variety of sleep disorders were randomly chosen from 60 pre-scored PSGs recorded at the sleep centre in Calgary. Arousals (n = 2695) were scored according to criteria recommended by the American Academy of Sleep Medicine. 271 arousals from 3 records were visually scaled (by MY) between 0 and 9 (most intense). The EEG signals' time and frequency characteristics were obtained using wavelet analysis. An automatic algorithm was developed to scale arousal intensity based on changes in EEG wavelet properties and the pre-scaled training set (with 271 arousals). HR response was measured as the difference between the peak HR in the interval [arousal-onset to (arousal-end + 8 seconds)] and pre-arousal HR.

Results: Arousal intensity varied considerably within patients (scales ranged from 2 to 7 in all files) and between patients (average patient scale ranged from 3.4 to 5.9). There was a strong correlation between HR response and arousal scale within each patient (average r: 0.95 ± 0.04). The slope of the relationship between HR response and arousal scale varied among patients (0.7-2.4 min⁻¹/unit scale).

Conclusion: Arousal intensity can be automatically quantified and has a strong correlation with the arousal-associated increase in heart rate. The gain of the relationship between arousal intensity and HR response varies among subjects.

Support (If Any): YRT Ltd, Winnipeg; FMC Sleep Centre Development Fund.

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EVALUATIONS OF EFFECTS OF HIGH REBOUND AND LOW REBOUND MATTRESS PADS ON NOCTURNAL SLEEP AND ITS ASSOCIATED PHYSIOLOGY IN ELDERLY SUBJECTS

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Introduction: We have reported at SLEEP 2013 that airweave, a high rebound [HR] mattress with breathable structure, induces effective heat loss (i.e., a larger decline in core body temperature [CBT]) and enhances deep sleep compared to low rebound [LR] pressure-absorbing mattresses, during the initial phase of nocturnal sleep in young healthy males. Dysregulation of temperature at bedtime, especially in elderly subjects, may interfere with the sleep occurrence or quality. We therefore evaluated effects of HR mattresses on sleep and its associated physiology in elderly subjects.

Methods: The study was conducted in 20 healthy elderly males, between age 55 to 65, with a randomized cross over single-blind design of one night PSG (23:00 to 07:00) at the sleep laboratory with 1-2 day intervals. The mattress pads were placed on regular beds equipped in the laboratory. The mean (± SD) of age of the 20 subjects was 61.2 ± 3.2 yrs, height: 169.2 ± 5.8 cm, weight: 61.6 ± 5.4 kg, BMI: 21.6 ± 2.0, PSQI: 5.8 ± 3.5. In addition to the PSG, number of roll-over during sleep, EKG heart rate variability, rectal temperature were monitored and assessed. Subjective sleep evaluations were done on the following morning, using visual analogue scales. Performance was also evaluated with psychomotor vigilance test. The significances of the differences of effects between HR and LR were evaluated with the paired-t test, except for effects on rectal temperature for which a repeated measures ANOVA with a grouping factor was applied.

Results: As we observed in young subjects, the CBT in elderly subjects rapidly decreased with HR, while the decline of the CBT with LR was modest and remained 0.2-0.3°C higher than that with HR, between 23:00 and 01:00. In our previous study in young subjects, we observed a significant increase in stage 4 with HR between 23:00 and 01:00. The elderly subjects in the current study had small amounts of SWS during this period (HR: 14.3 min (stage 3), 1.1 min (stage 4), LR: 14.7 min (stage 3), 0.5 min (stage 4)). However, delta EEG power between 23:00 and 01:00 was significantly increased with HR (+17%, p = 0.02) compared to that with LR. Subjects entered sleep rapidly with both HR (7.1 ± 3.4 min) and LR (6.7 ± 3.0 min).

Conclusion: The main effects of HR observed in young subjects (i.e., large decline in CBT associated with enhanced delta sleep) was reproduced in elderly subjects, implying that effective heat loss occurred with HR while in bed, and this may facilitate restorative sleep.

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OBJECTIVE SOURCES OF SUBJECTIVE SLEEP QUALITY IN OLDER MEN AND WOMEN

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Introduction: Sleep quality is a fundamentally subjective experience and without invoking a philosophical conundrum, there is no way for a clinician to “know” how a patient is experiencing sleep and its relative quality. There seems to be no simple, single objective measurement that captures such a complex phenomenon.

Methods: We examined 459 older women and 1024 older men who participated in the Study of Osteoporotic Fractures (SOF) and Osteoporotic Fractures in Men (MrOS) study, respectively. All participants had an overnight polysomnographic sleep recording and rated their sleep on three 5-point scales (Light vs. Deep, Short vs. Long, Restless vs. Restful), with 1 being the ‘lesser’ quality. We analyzed data using stepwise ordinal logistic regression with predictor variables describing sleep [total sleep time (TST), sleep efficiency (SE), sleep latency, apnea hypopnea index (AHI), number of periodic limb movements associated with arousals per hour of sleep], demographics [age, race, education, health], and psychiatric [Geriatric Depression Scale, Goldberg Anxiety Index, Pittsburgh Sleep Quality Index (PSQI), and Mini-Mental State Exam (MMSE, women) or Teng MMSE (men)] measures. Men and women were analyzed separately.

Results: Deeper self-reported sleep in both men and women was associated with higher SE and TST, lower PSQI and AHI, and additionally by race (non-White) and age (older) in men. Longer sleep was associated with higher SE and TST, and lower PSQI in both men and women, and additionally by lower mental status in men and lower AHI and education level in women. Restful sleep was associated with higher SE and TST in both men and women, and additionally by less education and anxiety in women and lower PSQI and older age in men.

Conclusion: Subjective impression of sleep quality is differentially influenced between the sexes by a variety of factors, including objective measures of sleep, demographics, and anxiety.

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RELATIONSHIP BETWEEN PERIODIC LIMB MOVEMENT INTENSITY AND ASSOCIATED CHANGES IN HEART RATE AND THE ELECTROENCEPHALOGRAM

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Introduction: Periodic limb movements during sleep (PLMs) are often associated with cortical EEG arousals and tachycardia. The intensity of PLMs varies considerably within and between subjects, from barely meeting diagnostic criteria to very extensive changes on the polysomnogram (PSG). Conventional manual scoring of sleep measures the frequency of PLMs but does not quantify their intensity. We hypothesized that quantifying PLM intensity may provide additional information re-

garding their physiological consequences. Our objective was to develop an algorithm for automatic scoring of PLM intensity and to determine the relationship between PLM intensity and the associated changes in EEG and heart rate (HR).

Methods: PSG records of 11 patients with at least 50 PLMs/record were analyzed. PLMs and PLM-related arousals were scored according to criteria recommended by the American Academy of Sleep Medicine (AASM). To quantify the PLM intensity, the anterior tibialis EMG signal was rectified and the intensity was defined as the integral of the rectified signal's envelope. The change in EEG signal was quantified using an automatic algorithm that was recently developed for scaling arousals (scale from 0 to 9). HR response was the difference between peak HR in the interval [PLM-onset to (PLM-end + 8 seconds)] and HR preceding PLMs.

Results: Consistent with previous studies, we observed significant changes in EEG even for PLMs not associated with AASM-scored arousals. Average PLM intensity ranged 15-307 μ V.sec among patients. There was a strong correlation between PLM intensity and HR response ($2.58+0.037*PLM$ intensity; $r^2 = 0.97$), and between PLM intensity and arousal scale ($1.92+0.016*PLM$ intensity; $r^2 = 0.94$), up to a PLM intensity of 100 μ V.s. Beyond this point, there was no further increase in HR response or arousal scale.

Conclusion: PLM intensity is strongly correlated with the PLM-associated EEG and HR responses. Measurement of PLM intensity may provide additional clinically-useful information in evaluating this disorder.

Support (If Any): YRT Ltd, Winnipeg, Canada.

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A NOVEL ACTIGRAPHY ANALYSIS METHOD FOR DETECTING THE EFFECTS OF TREATMENT ON DISTURBED SLEEP IN CHILDREN WITH AUTISM

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Introduction: Nighttime actigraphy data is often analyzed to estimate polysomnography-type endpoints such as “wake after sleep onset” (aWASO). To explore the possibility that additional information could be obtained by analyzing the motion data with no assumptions about sleep detection, a novel analysis was applied to the actigraphy data.

Methods: The study population consisted of 10 children with autism spectrum disorder, ages 4-9 years, participating in a trial of supplemental melatonin for insomnia. Children wore actiwatches (Philips Respironics) nightly for 17 weeks, and overnight polysomnography was recorded at baseline and during treatment with melatonin. Parents kept a nightly sleep diary to record bedtime, waketime, and night wakings. Standard actigraphic analysis software was used to calculate aWASO. The nighttime activity data was also successively smoothed 5 times with a moving Gaussian window. The number of times each smoothed curve exceeded a value of 40 counts/min during the night was counted as S1 to S5, with S5 representing the number of nighttime peaks in the most heavily smoothed curve.

Results: A peak in the S5 curve accompanied each night waking lasting 5 or more minutes recorded on polysomnography and sleep diaries. Apparent additional night wakings not recorded on sleep diaries were also detected as peaks in the S5 curves. Compared to baseline, there was a significant decrease in S5 peaks with treatment ($p = 0.028$; related-samples Wilcoxon signed rank test). Other measures of night wakings, including aWASO, did not change significantly.

Conclusion: Analysis of actigraphy data as a motion signal may provide objective and useful sleep endpoints for characterizing home sleep patterns and detecting the effects of treatment.

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CHALLENGE COMPARISON OF TWO ACTIVITY MONITORS TO POLYSOMNOGRAPHY FOR SLEEP/WAKE ESTIMATION IN HEALTHY ADOLESCENTS

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Introduction: Given the strong interest in the relationship between sleep and obesity behaviors, validating activity devices that can accurately capture both the sleep/wake schedule and daytime physical activity is important. Our aims were to: (1) determine the validity of a widely-used commercial physical activity monitor for assessing sleep (a) during a standard overnight PSG and (b) when challenged by episodes of quiet wakefulness and (2) examine the monitor's inter-device reliability when compared to a sleep-validated actigraph

Methods: Twenty adolescents (mean age = 15.5 y, mean BMI_{50th} = 63.7) were studied under dim light in-lab conditions (< 20 lux). Adolescents underwent a 12-day fixed light-dark schedule at-home with nights 13 (adaptation) and 14 recorded in-lab followed by 19-cycles of a 4-h forced desynchrony schedule (FD; 1.5 h-nap/2.5 h-wake). All participants wore the Sensewear® Pro3 Armband (upper-arm) and AMI Motionlogger Octagonal Actigraph (wrist) on their non-dominant arm in-lab. Polysomnography (PSG) was recorded during all sleep intervals. Epoch-by-epoch sleep/wake data (epoch = 1-minute) were examined for adaptation (standard) and 19 FD cycles (challenge). Total sleep time (TST), wake after sleep onset (WASO), sleep efficiency (SE), sensitivity (true-sleep [TS]/false-sleep [FS]+TS), specificity (true-wake [TW]/false-wake [FW]+TW), and accuracy $[(TS+TW)/(TS+FS+TW+FW)]$ were calculated.

Results: The standard night (Aim-1a) showed no differences between armband and PSG for TST ($P = 0.353$), WASO ($P = 0.293$), or SE ($P = 0.352$). For the challenge compared to PSG (Aim-1b), the armband overestimated WASO (Mdifference = -2.14 min; $P = 0.032$). Significant differences were also found across FD periods for TST ($P = 0.007$ -0.045), WASO ($P = 0.001$ -0.032), and SE ($P = 0.007$ -0.047). For inter-device reliability compared to the actigraph (Aim-2), the armband overestimated WASO (Mdifference = 3.95 min; $P = 0.003$), but underestimated TST (Mdifference = -11.3 min; $P = 0.005$) and SE (Mdifference = -12.5%; $P = 0.01$). The armband also showed lower sensitivity (Mdifference = -0.11; $P = 0.005$), but greater specificity (Mdifference = 0.11; $P = 0.01$) with no difference in accuracy ($P = 0.117$).

Conclusion: The armband was comparable to PSG during a standard recording; however, both the device type and protocol period impacted sleep parameters and epoch-by-epoch data during the challenge. Thus, the armband may not be as effective in estimating sleep/wake patterns outside a "typical" night or if disturbed sleep is present.

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ACCURACY OF NECK ACTIGRAPHY IN THE ASSESSMENT OF BEHAVIORAL SLEEP/WAKE

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Introduction: Wrist actigraphy is conventionally used to provide a behavioral assessment of sleep vs. wake. This study evaluates the accuracy of actigraphy acquired from the back of the neck in patients with obstructive sleep apnea.

Methods: Thirty-three subjects (26 males and 9 females, BMI 28 ± 3.1 kg/m², age 50 ± 9.3 years) completed laboratory polysomnography (PSG) while concurrent measurements were obtained with a neck-device that determined sleep/wake and neck position with an accelerometer. Thirty-second epochs were classified as sleep or wake in real-time and stored in the memory of the neck-device. Approximately four-weeks after their baseline study, 20 subjects completed a follow-up PSG with the neck-device additionally delivering vibro-tactile supine avoidance feedback. The mean apnea-hypopnea indexes at baseline and follow-up were 24 ± 18.1 and 8.6 ± 8.8 . After alignment, epoch by epoch comparisons were made between the PSG and the neck-device. Individual results for sleep (sensitivity) and wake (specificity), sleep efficiency, sleep onset, and wake-after-sleep-onset (WASO) were then averaged across subjects.

Results: The mean across-subject sensitivity and specificity were 89 ± 9.2 and 57 ± 17.2 . Of the 53 studies, the sensitivity < 0.80 and the specificity < 0.50 in 16% and 35% of the cases, respectively. The neck-device misidentified sleep efficiency with a $\geq 10\%$ discrepancy in 15 cases (29.3%), with sleep efficiency under-reported in 7 cases and over-reported in 8 cases. Differences between electrophysiological and actigraphy-based sleep onset were within 15 minutes, and WASO differences were within 45 minutes, in 77.4% of the cases, respectively. A trend toward improved sleep quality resulting from decreased sleep disordered breathing severity as a result of positional therapy was apparent in both PSG and actigraphy-based sleep efficiency, total sleep time, and WASO.

Conclusions: Neck-based actigraphy appears comparable to wrist actigraphy in the detection of sleep vs. wake and provides a reasonable estimate of sleep efficiency and sleep onset.

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SCREENING FOR OBSTRUCTIVE SLEEP APNEA: RE-EXAMINING COMMON SCREENING TOOLS

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Introduction: To help clinicians decide which test will better rule in or out obstructive sleep apnea (OSA) and when to order polysomnography (PSG), we compared the screening characteristics of common OSA screening tests (questionnaires, clinical predictors, or combinations) at different cutoff points.

Methods: Patients' charts (2012-2013) at a sleep disorders center were reviewed; looking for adult patients referred for overnight PSG to evaluate for OSA and who had completed STOP and Epworth Sleepiness Scale (ESS) questionnaires before admission for PSG. Of the 141 patients included, 97 (67%) were diagnosed with OSA. Demographic, anthropometric, clinical, and PSG data was collected and analyzed for the 2 groups, OSA vs. no OSA. Contingency Table Analysis was used to calculate sensitivity, specificity, and likelihood ratios for ESS, STOP, and STOP-BANG questionnaires. Different cut off points as well as clinical and anthropometric predictors of OSA were evaluated.

Results: Among screening questionnaires, ESS (cutoff = 15) had lowest sensitivity (0.28) but highest specificity (0.73), while ESS (cutoff = 10) had a sensitivity of 0.51 and specificity of 0.50. STOP (cutoff = 2) had high sensitivity (0.83) but low specificity (0.34). STOP-BANG (cutoff = 3) had highest sensitivity (0.95) but lowest specificity (0.21). Among all screening models, oximetry (lowest O₂ saturation during sleep \leq 89%) had highest sensitivity (0.97) and second highest specificity (0.66). All results were statistically significant (p -value < 0.05), except those for ESS (cutoff = 15 and 10). The positive test result of oximetry indicated a small increase in the probability of OSA being present (+LR = 2.84), while the negative test result indicated a large decrease in the probability of OSA being present (-LR = 0.05). The results of all other tests indicated minimal change in detecting OSA.

Conclusion: A combination of screening tools can be used to increase the accuracy of screening for OSA, and we recommend overnight oximetry to be part of any combination.

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EVALUATION OF AN IN-HOME MULTI-CHANNEL PORTABLE DEVICE AS COMPARED TO AN OVERNIGHT IN-LAB POLYSOMNOGRAPHY TO SCREEN FOR OBSTRUCTIVE SLEEP APNEA IN OLDER ADULTS

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Introduction: Obstructive sleep apnea (OSA) is a major public health concern. Overnight in-lab polysomnography (PSG) is the gold standard for OSA diagnosis but it is limited by its cost and access. The Berlin questionnaire and type 3 portable, multi-channel screening devices (PMCS) have reliably identified individuals at high risk for OSA. The use of the PMCS at home by older adults has not been established. This pilot study compares the effectiveness of PMCS administered by older adults to the Berlin and to overnight in-lab PSG.

Methods: 8 Veterans (mean age: 67.85 (SD: 3.3); 100% males), part of a larger sleep study, using a single night at-home ApneaLink Plus (ResMed Corporation, Poway, CA), followed by a single night in-laboratory PSG.

Results: One subject was excluded due to device malfunction. The Berlin questionnaire demonstrated sensitivity of 83% and specificity of 100% at AHI < 10 , sensitivity of 100% and specificity of 83% at AHI ≥ 10 . The PMCS demonstrated sensitivity of 100% and specificity of 100%. Correlations of AHI and RDI between the PMCS and PSG were high ($r = 0.99$) but not significant ($p = 0.19$).

Conclusion: The PMCS was easy for older adults to use and effective in identifying older adults with significant OSA, providing a cost-effective alternative to in lab PSG.

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THE FEASIBILITY OF RESPIRATORY MOTION MEASUREMENT IN SLEEP USING UNCONSTRAINED TECHNIQUES FOR PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Polysomnography (PSG) is the gold standard for the diagnosis of obstructive sleep apnea (OSA). PSG has limitations including inconvenience, high cost, long waiting times, limited availability and an artificial setting. Some researchers proposed the use of pressure-sensitive sensors installed in a bed to monitor body activities lying in bed (e.g. movements, postures, positions and breathing patterns). We used a pressure sensing mattress as an assistive evaluation tool for respiration monitoring during sleep. This study evaluated the correlation of predicted breathing patterns between an unconstrained technology system and PSG.

Methods: Patients with severe snoring problems in Tainan Hospital were recruited. These subjects received the measurements of PSG and the unconstrained technology system simultaneously during the study night. The unconstrained technology system included a pressure sensing mattress, 49-channel analog circuits, digital circuits, a serial communication interface, internet transmission module and a computer. The respiratory movement obtaining from pressure sensing signals was used to evaluate the events of apnea or hypopnea during sleep. Forty-nine pressure sensing signals were processed by signal fusion analysis, feature extraction and body activity recognition. With the algorithm of linear discriminant analysis, the respiration patterns were predicted.

Results: Forty patients completed the whole protocol. Thirty-four (85.0%) were male subjects. The average age was 44.4 years (SD = 14.2). The mean body mass index (BMI) was 26.7 (SD = 4.2). Total sleep time was 361.2 minutes. Sleep efficiency was 80.7%. Mean of apnea-hypopnea index (AHI) was 33.1 (SD = 24.4). The factors relating to the poor sleep quality including annoying instrument signal cables (62.5%), unfamiliar test environment (25.0%) and uncomfortable bed (17.5%). For the prediction of OSA, the correlation coefficient (r) between the unconstrained technology system and PSG was 0.997.

Conclusion: It showed that the unconstrained technology system using the pressure sensing mattress could be feasible for respiration monitoring during sleep.

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COMPARISON OF APNEA HYPOPNEA INDEX (AHI) USING RECORDING TIME VERSUS SLEEP TIME

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Introduction: The gold standard test for obstructive sleep apnea (OSA) is polysomnography (PSG). Recently, both home sleep testing (HST) and lab PSG are used to diagnosis OSA. True (EEG) sleep time (TST) is used for PSG-AHI calculation. Total recording time (TRT) is used for HST-AHI calculation. OSA treatment options, degree of cardiac risks, and CPAP coverage are based on either AHI. Insurances recognize HST-AHI for OSA diagnosis, yet different methods of calculation are used for HST-AHI and PSG-AHI. There are head-to-head studies

comparing the HST and PSG-AHI but the subject numbers are low due to inherent study costs. There are studies showing night-to-night variability independent of the study type or location, yet sleeping with PSG or HST leads is not “normal” sleep, independent of location. Using TRT assumes impossible 100% sleep efficiency (SE), especially inaccurate for apneics. Using the patient’s PSG SE is a representative assessment of TST and TRT (for that patient). This study’s purpose is (1) To compare the HST-AHI and PSG-AHI using existing PSG data (2) To determine if different AHI calculation methods change the patient’s categorization of no apnea (AHI = 0-4.9), mild (AHI = 5-14.9), moderate (AHI = 15-29.9), or severe apnea (AHI \geq 30).

Methods: Data from 11,213 Penn Sleep full-night PSGs (1/06-6/13) were reviewed. Total number of apneas-hypopneas, TST, and TRT were used to calculate HST-AHI and PSG-AHI. Patients were categorized into no, mild, moderate, and severe apnea by PSG-AHI and HST-AHI. Frequencies of category changes using TST and TRT were analyzed.

Results: For 11,213 PSG studies, the mean HST-AHI was 10.7 (SD12.1) and the mean PSG-AHI was 15 (SD17.64). For 4564 patients with no apnea by HST-AHI, 81% had no OSA, 18.5% had mild, 0.4% had moderate, and 0.2% had severe OSA by PSG-AHI. For 2995 with mild apnea by HST-AHI, 70% had mild, 27.4% had moderate, and 2.5% had severe apnea by PSG-AHI. For 1898 with moderate apnea, 63.2% had moderate and 36.8% had severe OSA. All 756 with severe HST-AHI had severe PSG-AHI. The difference between HST-AHI and PSG-AHI was greater for men. ($P < 0.001$ for all calculations).

Conclusion: Use of TRT (HST) underestimates apnea and affects treatment options for a significant number of patients. The diagnosis was missed in nearly 20% and underestimated for 27% with mild (HST) apnea and 37% with moderate (HST) apnea. This difference was greater for men. Further identifiers will assist in pre-certs for HST and interpretation of HST results for OSA cardiac risks and treatment options.

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TRANSITION OF OUTPATIENT MANAGEMENT OF OBSTRUCTIVE SLEEP APNEA TO PRIMARY CARE MANAGERS: A PROCESS IMPROVEMENT PROJECT

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Introduction: Diagnoses of obstructive sleep apnea (OSA) in the military have risen dramatically over the past decade, with a four-fold increase among those ages 20-24. This expanding demand is outpacing the capabilities of military sleep disorders centers (SDCs). Previous studies demonstrated non-inferiority in OSA management by primary care managers (PCMs) compared to sleep specialists, but obstacles to the transition of care of uncomplicated OSA patients remain. The purpose of this two-part study is to educate PCMs in order to improve the implementation and follow up of appropriate CPAP therapy in uncomplicated patients enrolled in one military health system (MHS).

Methods: All cases from 2012 at one military SDC were analyzed regarding outcomes in which the PCM placed a consult, in-lab polysomnography (PSG) and optimal CPAP titration were performed, and the patient was referred back to the PCM for management. Primary endpoints were correct ordering of recommended PAP mode and pressure and adequate supplies/refills. Secondary endpoints included face-to-face PCM follow-up and re-referral back to SDC.

Results: 50 patients met the criteria listed above and PCMs ordered CPAP in 44 cases (88%). 35 patients' orders were consistent with recommendations (80%). PCMs ordered CPAP supplies in 28 cases (63%); three orders provided adequate supplies and refills (11%). Face-to-face PCM follow-up occurred in eight cases (16%). Six patients (12%) were sent back to the SDC.

Conclusion: Current management of uncomplicated OSA by PCMs is suboptimal. Education of PCMs on OSA diagnosis, report interpretation, and CPAP adherence and management strategies, in addition to improvement in written communication on reports are predicted to improve adherence to and correct ordering of CPAP therapy. Further investigation into follow-up patterns with PCMs vs. SDCs in the MHS is recommended, as this is a potential barrier to effective OSA therapy.

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WHAT IS THE COST OF POOR SLEEP FOR COLLEGE STUDENTS? CALCULATING THE CONTRIBUTION TO ACADEMIC FAILURES USING A LARGE NATIONAL SAMPLE

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Introduction: Predicting college student academic success and retention is a top priority for university administrators, especially in tuition driven climates. Withdrawing from even one course in a student's freshman year increases the probability of leaving the university by 14%. Historically, studies predicting student attrition have not taken into account sleep. Although we know students with untreated sleep problems are at risk for multiple negative health outcomes, the impact of poor sleep specifically on measures of academic success has not been analyzed using a national sample of two-year and four-year public and private institutions.

Methods: We analyzed the Spring 2009 American College Health Association National College Health Assessment dataset (N = 72,966, 63% female, 75% white) to evaluate factors that predict undergraduate academic problems including dropping a course (DC), earning a lower course grade (LCG), and having a lower cumulative GPA. Principal

components analysis was used to reduce the ten sleep related variables in the survey to three meaningful factors: diagnosis of a sleep disorder, excessive sleepiness, and disturbances in sleep timing/maintenance. We performed LOGITIC and OLS regression analyses to isolate the effect of these sleep factors on likelihood of experiencing academic problems. In estimation of this, we held constant demographic variables (e.g., race, ethnicity, gender, psychiatric diagnosis), academic variables (e.g., class year, learning disability), drug and alcohol use, perceived stress and employment demand.

Results: For all three regression specifications, the impacts on academic problems are similar. Following clinical depression diagnosis and self-rated 'tremendous stress,' sleep timing and maintenance problems are the highest predictors of academic problems ($\beta_{DC} = 0.298$, $\beta_{LCG} = 0.216$, $\beta_{GPA} = 0.066$). While factors such as binge drinking, marijuana and other illicit drug use, and work hours contribute significantly to the model, their impact is far less than disturbed sleep.

Conclusion: Few universities invest wellness resources in promoting healthy sleep, despite sleep's enormous impact on academic success. Using our regression parameter estimates, we can calculate the cost effectiveness of implementing behavioral sleep interventions on college campuses.

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SLEEP DURATION IS ASSOCIATED WITH ACCESS TO HEALTHCARE BUT RELATIONSHIPS DEPEND ON RACE/ETHNICITY

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Introduction: Short sleep duration is associated with many adverse health outcomes, as well as demographic and socioeconomic factors. Sleep may represent a modifiable factor linking minority and/or low socioeconomic status with poor health. One potential reason for health outcomes associated with sleep duration may be healthcare access, and this may depend on race/ethnicity.

Methods: Data from the 2009 Behavioral Risk Factor Surveillance System was used. N = 26,765 adults provided data on sleep and healthcare access. Sleep duration was assessed as total sleep in a typical 24-hour period and coded as ≤ 4 , 5, 6, 7, 8, 9, and ≥ 10 hrs. Access to any medical insurance (yes/no) and having foregone medical care in the past 12 months due to cost (yes/no) were also assessed. Population-weighted, binary logistic regression analyses assessed associations between sleep (reference = 7 hrs) and healthcare access outcomes, adjusted for age, sex, race/ethnicity, education, employment, overall health, and state-of-residence.

Results: Lack of health insurance was more likely among ≤ 4 hr (OR = 1.75; 95%CI [1.24, 2.45]; p = 0.001) and 5 hr (OR = 1.43; 95%CI [1.07, 1.90]; p = 0.015) sleepers. A significant sleep*race/ethnicity interaction (p = 0.001) was found. Among non-Hispanic Whites, this pattern was maintained for ≤ 4 hrs (OR = 2.42; 95%CI [1.62, 3.63]; p < 0.0001) and 5 hrs (OR = 1.51; 95%CI [1.10, 2.06]; p = 0.011). No relationships were seen among other groups. Foregoing medical care (even after adjustment for access to health insurance) was more common among ≤ 4 hrs (OR = 2.17; 95%CI [1.52, 3.09], p < 0.0001), 5 hrs (OR = 1.48; 95%CI [1.13, 1.95] = p < 0.005) and 6 hrs (OR = 1.40; 95%CI [1.14, 1.70]; p = 0.001). Again, this relationship depends on race/ethnicity (interaction p = 0.0002). Among non-Hispanic Whites, this relationship was maintained for ≤ 4 hrs (OR = 2.32; 95%CI [1.60, 3.34], p < 0.0001), 5 hrs (OR = 1.98; 95%CI [1.47, 2.67]; p < 0.0001), and 6 hrs (OR = 1.54; 95%CI [1.23, 1.92]; p < 0.0001). However, among Blacks/African-Americans, increased likelihood was found for ≤ 4 hrs (OR = 2.16; 95%CI [1.17, 4.03]; p = 0.014), among Hispanics/Latinos, decreased likelihood was

found for 5 hrs (OR = 0.27; 95%CI [0.09, 0.79]; $p = 0.017$) and 9 hrs (OR = 0.10; 95%CI [0.03, 0.34]; $p < 0.0001$), among Asians/Others, increased likelihood was found for 6 hrs (OR = 2.94; 95%CI [1.19, 7.27]; $p = 0.019$), and among Multiracial respondents, decreased likelihood was found for 9 hrs (OR = 0.02; 95%CI [0.002, 0.22]; $p = 0.002$).

Conclusion: Short sleep duration was associated with decreased healthcare access and foregoing medical care due to cost, but this relationship depended on race/ethnicity. Non-Hispanic Whites may show a more robust relationship between short sleep and healthcare access/utilization. Other factors may be more prominent in other groups.

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RELATIONSHIPS AMONG DAYTIME SLEEPINESS, SLEEP QUALITY, AND COPING STYLE IN FAMILY CAREGIVERS OF INDIVIDUALS WITH DEMENTIA

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Introduction: Sleep disturbance is highly prevalent among family caregivers of individuals with dementia. Caregivers' sleep is often disrupted by care-recipients' nocturnal disturbances (e.g., assistance with toileting, wandering). Inadequate sleep causes caregivers' daytime sleepiness which may decrease their daytime functioning. Furthermore, daytime sleepiness may result in caregivers taking naps during the day which may further interrupt their nightly sleep quality and quantity. Caring for a loved one with dementia at home is challenging and caregivers' coping strategies may play an important role in their well-being. This study aimed to examine the associations among caregivers' daytime sleepiness, sleep quality, and coping style.

Methods: This study used a cross-sectional design. Caregiver participants were recruited from the Alzheimer's Association Western New York Chapter at Buffalo. Measures include Actigraph (wore for 7 days), Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and Brief Cope. Descriptive and correlational statistics were used for data analysis.

Results: A total of 48 family caregivers participated in the study. Findings indicate that caregivers who used more dysfunctional coping strategies (e.g., substance use, self-blame, denial, behavioral disengagement) had more daytime sleepiness ($p < 0.05$) and longer sleep latency ($p < 0.05$). Caregivers who used more problem-focused (e.g., use of instrumental support, active coping, planning) and emotion-focused (e.g., use of emotional support, humor, positive reframing, acceptance) coping strategies had less daytime sleepiness ($p < 0.05$), and better sleep quality ($p < 0.05$). Caregivers reported more daytime sleepiness had less total sleep time ($p < .05$) as measured by both actigraph and PSQI.

Conclusion: Daytime sleepiness was significantly associated with caregivers' sleep quality and coping strategies. Caregivers who experienced more daytime sleepiness reported poorer sleep quality, used less problem-solving and emotional coping strategies, and used more dysfunctional coping strategies. Our findings provide preliminary evidence suggesting interventions that address daytime sleepiness and coping strategies to improve caregivers' sleep quality.

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IMPACT OF E-CONSULTS IN IMPROVING SYSTEM EFFICIENCY IN MANAGEMENT OF SLEEP APNEA: A SINGLE CENTER VAMC EXPERIENCE

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Introduction: Literature suggests that VA population is at increased risk of undiagnosed sleep apnea. At Milwaukee VAMC, prolonged Sleep Clinic wait times historically delayed access to treatment. In July 2008, a chart review (E-Consult) triage program for sleep apnea was implemented to improve access.

Methods: This is a retrospective review study. Electronic medical record (EMR) was interrogated between 2008 to 2012 to determine annual trends in delivery of service for management of sleep apnea. The following E-consult algorithm was created in 2008: 1) Sleep specialist reviews chart for every sleep consult; 2) For suspected sleep apnea, triaging for portable vs. in-laboratory attended sleep study is done according to AASM guidelines; 3) For confirmed sleep apnea, prescription of PAP therapy is provided within 10 days of consult. Sleep physicians provide feedback to primary care providers regarding management of simple cases through E-consult; 4) Data card download performed after 30 days on PAP therapy; 5) Patients with sleep disorders other than uncomplicated sleep apnea were scheduled for sleep clinic evaluation. Program is supervised by two board certified sleep physicians.

Results: From 2008 to 2012, interval between sleep consult and PAP prescription decreased from average > 90 days to < 15 days. Total number of sleep consults/year increased 300% from 246 to 761. Number of E-consults/year increased from 0 to 624. Number of sleep studies/year performed at the VA increased 150% from 373 to 573. Number of PAP prescriptions/year increased 150% from 456 to 684 while data downloads/year increased 800% from 150 to 1227. All of the efficiency measures described showed statistically significant change, $p < 0.005$. There was no change in number of sleep staff physicians or ancillary staff.

Conclusion: At Milwaukee VAMC, an E-consult based management of sleep apnea improved clinical efficiency through increased as well as faster access to diagnostic and treatment interventions.

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TRENDS IN OSA DISEASE SEVERITY OVER A DECADE: THE VA SAN DIEGO EXPERIENCE

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Introduction: The Veterans Health Administration (VA) is one of the largest healthcare systems in the United States. Comprised of predominantly older overweight males, Veterans are at higher risk for obstructive sleep apnea (OSA) than the general population. The VA San Diego Pulmonary Sleep Program has maintained a patient database since 1998, providing a unique perspective on OSA trends in this population.

Methods: This was a retrospective, cross-sectional, database review study utilizing a local clinical database. Variables included age, gender, apnea-hypopnea index (AHI) and Epworth Sleepiness Scale (ESS).

Results: The dataset was comprised of 12,548 patients from 2004-2013 and contained data on age, AHI and ESS. The mean age decreased over time from 55.2 ± 9.9 (24-74) in 2004 to 51.3 ± 13.8 (22-84) ($F = 13.301$ (1,9); $p < 0.0001$; valid $n = 12,548$). The mean AHI decreased over time from 40.3 ± 21.9 (5-119) in 2004 to 25.7 ± 20.4 (5-124) in 2013 ($F = 9.287$ (1,9); $p < 0.0001$; valid $n = 11,260$). The mean ESS increased by 0.8 points from 2004 (10.4 ± 5.2 ; 0-24) to 2013 (11.2 ± 5.5 ; 0-24) ($F = 2.156$ (1,9); $p = 0.020$; valid $n = 10,539$) but does not represent a clinical

cally meaningful change. Between 2004 and 2013, the percentage of severe cases decreased from 60% to 30% and mild cases increased from 7% to 35%, respectively.

Conclusion: The main trends found in this large, retrospective review of the last decade of OSA patients at the VA San Diego are an increasingly younger population and more mild OSA severity. Mild OSA now accounts for over one-third of all diagnosed OSA patients. There are several potential explanations for these findings, and further analysis is required. Nonetheless, these findings have clear implications for how best to clinically manage increasing numbers of mild cases, particularly when it is known that adherence with continuous positive airway pressure (CPAP), the gold-standard therapy, is particularly challenging in this group.

Support (If Any): VA San Diego Healthcare System.

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EVALUATION OF SLEEP MEDICINE EDUCATION IN U.S. PSYCHIATRY RESIDENCY PROGRAMS

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Introduction: Clinical research demonstrates sleep quality is closely tied to a variety of psychiatric illnesses, including depression, anxiety, bipolar disorder, impulse control disorders, and schizophrenia. Further, sleep problems unrelated to psychiatric pathology often serve as a common chief complaint at many psychiatric clinic visits. Therefore it is essential that psychiatry residents be trained in the assessment, diagnosis, and treatment of sleep disorders.

Methods: In 2013, a 29-item peer reviewed sleep medicine education survey was created and distributed to 39 psychiatry chief residents at the 2013 Annual Chief Residents Tarrytown Meeting. The survey included questions about program size, sleep fellowship affiliation, didactics, sleep lab exposure, availability of faculty with board certification in sleep medicine, comfort in screening patients for common sleep complaints, ability to participate in sleep research, and the means by which certain sleep topics are taught. This survey provided an overall assessment of current sleep medicine education in psychiatry training programs across the U.S.

Results: Of the 39 psychiatry residency programs surveyed, 19 had a dedicated sleep medicine clinic and 6 offered a sleep fellowship. The survey demonstrated that 89% of the programs offered sleep medicine didactics, 38% offered training in cognitive behavioral therapy for insomnia, 34% offered sleep medicine rotations, 38% had programs with faculty board certified in sleep medicine, and 10% offered polysomnography lab exposure. At the end of their third year of residency, 72% of residents were comfortable screening for obstructive sleep apnea, 53% of residents were comfortable screening for restless legs syndrome, and 47% were comfortable screening for other sleep disorders.

Conclusion: While most programs offer sleep medicine didactics, only a minority offer sleep medicine rotations, polysomnography lab exposure, access to board certified sleep medicine faculty, and training in CBT for insomnia. There is significant room for improvement in educating residents about screening for sleep disorders. Increasing quality of sleep medicine education will improve patient care and may promote interest in sleep medicine fellowships.

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POOR SLEEP AMONG U.S. COLLEGE STUDENTS WITH ACADEMICS PERFORMANCE SUBSCALES

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Introduction: College students often report disrupted sleep patterns and sleepiness, and consistently identify sleep problems in the top three issues influencing their academic performance. However, their sleep quality is not improving. Perhaps, a greater understanding of the associations and impacts of poor sleep quality (daytime sleepiness) on impaired academic performance would promote effective intervention development.

Methods: We analyzed a sample of 28,103 college students from Fall 2009 American College Health Association's National College Health Assessment II survey. Data analysis was descriptive to characterize the sample. Sleep quality was defined by five responses of "no problem," "a little problem," "more than a little problem," "big problem," and "a very big problem" for a question about daytime sleepiness interfering with activities in the last seven days. Sleep quality differences in academic performance subscales of physical, mental, extracurricular, and acute sickness were examined via Multivariate Analysis of Variance (MANOVA). Significant MANOVAs were followed by univariate tests for included variables. All statistical significances are reported at $p \leq .05$.

Results: Of 28,103 college students with a sleepiness problem, 63.8% were female, 22.04 years-old, 71.4% Caucasian, 48.8% single, and 92.8% full-time enrolled. Sleep quality differences in all academic performance subscales were significant, and poorer sleep quality negatively affected all academic performance subscales. Specifically, the frequency of negative impact on all four academic performance subscales significantly increased as the level of sleep problem worsened (all $ps \leq .001$) except for those with "no problem" and "a little problem" on the physical subscale.

Conclusion: Findings suggested that poor sleep quality (sleepiness) significantly influenced academic performance. Continued research to understand the key factors affecting college students' sleep may promote effective interventions and reduce the burden of chronic disease.

Support (If Any): Mennonite College of Nursing at Illinois State University awarded a University Research Grant to support this study.

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SLEEP BEHAVIOR AND MORNINGNESS-EVENINGNESS CHRONOTYPE OF MEDICAL TRAINEES AT THE BEGINNING OF THEIR TRAINING

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Introduction: Poor sleep quality and sleepiness remain common among medical trainees despite resident duty hours regulations. These may lead to cognitive impairment, compromised patient care, and car accidents. We hypothesized that poor sleep quality and hygiene, as well as daytime sleepiness may be prevalent in residents prior to their training.

Methods: We conducted a cross-sectional, anonymous survey of Tulane University medical trainees before the beginning of their training. Sleep quality was determined using the Pittsburgh Sleep Quality Index (PSQI), while sleep efficiency (SE) was calculated from PSQI data. The Morningness-Eveningness Questionnaire (MEQ), Epworth Sleepiness Score (ESS), and Sleep Hygiene Index (SHI) were employed.

Results: Ninety out of 91 subjects completed all questionnaires. Of those, 47.3% ($n = 43$) were male, 35.2% ($n = 32$) were married, and 75.8% ($n = 69$) were starting their PGY-1. Twenty-five percent of trainees had an ESS > 10 . The mean PSQI score was 4.6 ± 2.5 , and 30% of

trainees had poor sleep quality (PSQI score > 5), whereas the mean SE was $93.7 \pm 3.4\%$. The MEQ demonstrated that 13% (N = 12), 57.1% (N = 52), and 28.6% (N = 26) of subjects had morning, intermediate, and evening chronotypes, respectively. Unmarried residents had a higher prevalence of daytime sleepiness (32.2% vs. 12.5%, $p = 0.039$) and less morning-chronotype (17.2% vs. 50%, $p = 0.001$) compared to married residents. No differences in PSQI, MEQ, ESS, and SHI scores were observed between genders, races, and PGY levels. Among interns, women had poorer sleep hygiene (SHI, 34.9 ± 7 vs. 31.3 ± 5.5 , $p = 0.029$). Unmarried interns had a higher ESS (8.5 ± 3.5 vs. 6.4 ± 3.3 , $p = 0.03$), and less morning-chronotype (18.4% vs. 47.4%, $p = 0.015$). The morning-chronotype was associated with better sleep hygiene (29.5 ± 3.7 vs. 34.8 ± 6.9 , $p = 0.03$).

Conclusion: About 25-30% of trainees were sleepy and had poor sleep quality prior to starting their training. Single trainees tended to be sleepier and had a morning-chronotype less frequency. Early interventions to address residents with sleep problems, may lead to healthier sleep behavior and possibly more favorable patient outcomes.

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PERCEPTIONS OF MEDICAL INTENSIVE CARE UNIT ENVIRONMENT AND SLEEP AMONG PATIENTS AND CAREGIVERS

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Introduction: Poor sleep is believed to negatively impact clinical outcomes in the medical intensive care unit (MICU). The MICU environment significantly contributes to patient sleep disruption and is potentially modifiable. This study explored perceptions about the MICU nighttime environment and beliefs regarding the importance of sleep held by caregivers, patients and their families.

Methods: Using semi-structured interviews, MICU caregivers, MICU patients and families of MICU patients were asked to share their views on the overnight MICU environment and the importance of sleep. Interviews were recorded, transcribed and scored. Qualitative analysis of content was used to code, categorize and identify themes in the interview.

Results: Interviews included 7 physicians, 5 respiratory therapists, 5 nurses, 2 care assistants and 8 patient/family sets. Everyone interviewed (n = 27) agreed that MICU patient sleep is important. Interviewees (n = 7) endorsed a belief that sedated MICU patients were not bothered by noise or in-room disruptions. Three major themes emerged from patient/family interviews: (1) the amount and quality of sleep was caused by or related to sedating medications; (2) MICU patients slept at non-circadian times; (3) noise and disruption are expected in the MICU. Interviews with MICU staff revealed that caregivers overestimated the quantity or quality of patient sleep. Also, staff identified noise as the major environmental stressor with frequent room entry as the second most common stressor.

Conclusion: Staff, patients and family value sleep, yet they overestimate the amount of sleep attained and underestimate the amount of unnecessary disruption that occurs in the MICU. It is necessary to educate patients and caregivers about the physiologic importance of sleep. Further research is warranted to modify the MICU environment to promote sleep. The input and beliefs of patients, family and staff are important as they offer invaluable insights into MICU environmental stressors.

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NOISE AS A SOURCE OF MEDICAL INTENSIVE CARE UNIT SLEEP DISRUPTION

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Introduction: Sleep deprivation is virtually universal in critically ill patients. A variety of environmental and acute illness related factors disrupt sleep which is believed to be tightly linked to intensive care unit (ICU) delirium. In turn, delirium is associated with poor patient outcomes. Noise (unwanted sound) is a documented environmental cause of sleep disruption. Our study evaluated in-room sound levels under usual care conditions.

Methods: Sound data was gathered via overnight (8:00 PM to 8:00 AM) recording of MICU patient rooms with an Extech HD600 sound level meter set to record in A-weighted decibels (dBA) every 10 seconds with a fast response time and a decibel range of 30 to 130 dBA. For each night of recording, average sound (Leq) was determined on a minute-by-minute and whole night basis. Peaks were identified using 3 thresholds: 1) "Min+15" is a peak of sound that exceeds the average sound during the concurrent minute by greater than 15 dBA; 2) "L90+15" is a peak of sound which exceeds the overnight 90th percentile by 15 dBA; 3) "> 70 dBA" is any peak greater than 70 dBA. The frequency of peak occurrence was then described in terms of area under the curve (AC) for time that is free of excessive noise (i.e. AC = 1.0 conveys zero excessive noise).

Results: The average Leq from 8:00 PM to 8:00 AM across 27 patient nights was 54.10 dBA. The L90 across 27 patient nights was 59.73. When patient room sound was analyzed for peak sound occurrences, average AC was 0.62 for Min+15, 0.70 for L90+15 and 0.58 for > 70 dBA.

Conclusion: Medical ICU patients experience profound noise. Sound levels are high on average and sound peaks occur frequently in patient rooms. This could compromise a significant portion of the overnight sleep time as patients have only brief quiet periods. This is a modifiable entity which should be pursued as a point of intervention.

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SLEEP DISORDERS ASSOCIATED WITH DECREASED IN-HOSPITAL MORTALITY

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Introduction: The association of sleep disorders during episodes of in-patient care on hospitalization outcome measures, such as mortality, is poorly understood. We studied four common sleep disorders (insomnia, narcolepsy, sleep apnea, and restless legs syndrome) and their association with in-hospital mortality.

Methods: The Nationwide Inpatient Sample (NIS) provided longitudinal, retrospective data on a 20% stratified sample of United States patients admitted to community (non-federal) hospitals, selected between 2006 and 2011. Hospitalizations were categorized by the presence or absence of an associated sleep disorder (insomnia, sleep apnea, narcolepsy, or restless legs syndrome) as one of the principal or secondary diagnoses. The ICD-9-CM codes used were: insomnia (046.72, 327.00, 327.01, 327.02, 327.09, 780.51, 780.52), narcolepsy (347.00, 347.01, 347.10, 347.11), restless legs syndrome (333.94), and sleep apnea (327.20, 327.23, 327.29, 780.51, 780.53, 780.57). Central sleep apnea (327.21, 327.27) was excluded. Multivariate logistic regression was used to determine the associated odds of in-hospital mortality. Covariates controlled for included number of diagnoses or procedures, age,

race, gender, weekend or elective admission, low income, payer, hospital teaching status, selected co-morbid cardiac or medical diagnoses, mechanical ventilation, endotracheal tube placement, and cardiopulmonary arrest.

Results: We reviewed NIS data from 47,878,230 hospitalizations between 2006 and 2011 (national estimate of 235,748,264 hospitalizations). All four sleep disorders, individually modeled in a multivariate logistic regression, were associated with decreased odds of in-hospital mortality: insomnia 0.434 95% confidence interval: 0.419-0.450), narcolepsy 0.411 (0.352-0.481), sleep apnea 0.329 (0.324-0.334), and restless legs syndrome 0.462 (0.445-0.480); all confidence intervals had $p < 0.0001$.

Conclusion: The four selected sleep disorders appear to be associated with decreased odds of in-hospital mortality, when controlling for a variety of covariates reported in the NIS. Such associations may be stronger or more relevant for differing cohorts or clinical scenarios. Further prospective investigation evaluating the etiology of these associations is needed.

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DEVELOPING AND TESTING A SLEEP EDUCATION PROGRAM FOR COLLEGE NURSING STUDENTS

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Introduction: There is a pressing need to educate the future nursing workforce to increase understanding of healthy sleep practices, adverse health consequences of impaired sleep, and common sleep disorders. Unfortunately, sleep education has not been part of established undergraduate nursing curricula. Our goal was to develop a sleep education program and determine its effect on knowledge related to sleep and sleep disorders in undergraduate nursing students.

Methods: An interactive multiphase sleep education program including three sequential components with a total of 8-hour time commitment was developed: traditional in-classroom teaching, guided online self-learning, and interactive discussion with visual simulation technology. The program was implemented to a core nursing course offered to senior students in the Spring 2013. Pre- and post-tests on a quiz including 12 multiple-choice questions were used to determine whether application of this program improved students' knowledge related to sleep and sleep disorders.

Results: Fifty-seven students participated in this study. A baseline, the students believed the education of sleep and sleep disorders was extremely (43.9%) or fairly important (49.1%). After completing the program, among the 40 participants who completed the post-test, all of them believed that this education was extremely (80%) or fairly important (20%). Significant improvement was observed in the quiz performance after the education program compared to the scores at baseline (the percentage of correct answers: 68.8 ± 9.8 vs. 48.4 ± 11.8 , $p = 0.000$). The self-rated level of knowledge of sleep and sleep disorders was also increased (5.7 ± 1.5 vs. 3.9 ± 1.9 , $p = 0.000$).

Conclusion: This program demonstrated its feasibility and effectiveness of improving knowledge related to sleep and sleep disorders. Translating into the undergraduate nursing curriculum, it can lay a foundation for the care of patients with sleep disturbance or sleep disorders, and decreasing the health risks of nurses as care providers.

Support (If Any): 2012 American Sleep Medicine Foundation Educational Projects Award; Boston College Teaching, Advising and Mentoring Grant.

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SLEEP EDUCATION FOR MEDICAL STUDENTS AND PEDIATRIC RESIDENTS BY AN ONLINE SLEEP REVIEW COURSE

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Introduction: Sleep disorders are common and a significant health problem. Studies have shown a deficiency in sleep knowledge amongst physicians, attributed to a shortage of sleep training during medical school and residency. The purpose of this study was to assess pediatric residents and medical students sleep attitudes and knowledge, before and after an online sleep course.

Methods: Participants completed a pre-test, followed by an introductory lecture. Six online modules were then reviewed. The modules included: Introduction, History and Sleep Hygiene, Sleep Physiology, Sleep Disorders, and Sleep Pharmacology. Participants completed a post-test and a course evaluation once the modules were completed.

Results: 184 participants completed the pre-test. 126 participants completed the entire program (68%). Most of participants indicated minimal or no training in sleep medicine. Significant increase in sleep knowledge was seen in all participants and in the students and residents groups separately ($p < .0001$). Significant increase in attitude to sleep medicine for all participants ($p = 0.018$) and for the residents ($p = 0.005$) was found, but not for the students group ($p = 0.1909$). Participant's sleep behavior did not change significantly.

Conclusion: Sleep education was deficient in the participants. This online course was effective to improve their sleep knowledge and attitude about the importance of sleep. These improvements did not change their sleep behavior. The participants were pleased with the length and content of the modules, however they suggested the course be more interactive.

Support (If Any): American Sleep Medicine Foundation Grant Award # 71-EP-11.

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A COMPREHENSIVE CATALOGUE OF KNOWLEDGE AND SKILLS FOR SLEEP MEDICINE DEVELOPED IN EUROPE

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Introduction: Sleep medicine is evolving into a medical sub-specialty in its own and had been established in the US and Germany now. Educational programs are being implemented at different levels and by different medical associations in many European countries. However, these programs would benefit from a common sleep medicine curriculum. Therefore a catalogue of knowledge and skills' for sleep medicine is proposed for at least the countries in Europe. The board and the sleep medicine committee of the European Sleep Research Society (ESRS) have compiled the catalogue based on textbooks, standard of practice publications, systematic reviews, and professional experience.

Methods: The catalogue had been transferred to an online survey. The survey had been distributed to delegates from European countries involves in the ESRS. Finally the catalogue was validated by 110 delegates specialized in sleep medicine.

Results: The catalogue comprises 10 chapters covering physiology, pathology, diagnostic and treatment procedures, through to societal and organisational aspects of sleep medicine. Required levels of knowledge and skills are defined, as is a proposed workload of 60 points according to the European Credit Transfer System (ECTS). The catalogue is intended to be a basis for sleep medicine education, for courses, and for

examinations. This serves physicians with a medical specialty degree, PhD and MSc health professionals such as clinical psychologists and scientists, technologists and nurses, all of whom are professionally involved in sleep medicine.

Conclusion: The catalogue will become the basis for a comprehensive education in sleep medicine across disciplines. It will be the basis for curricula, courses and examinations in Europe.

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MEDICAL STUDENTS' EXPOSURES AND ATTITUDES ON SLEEP MEDICINE

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Introduction: Despite the high prevalence of sleep disorders within the population and annual healthcare costs associated with them, the recognition and diagnosis of these disorders among healthcare providers is low. This is likely due to the limited education that is provided at the undergraduate, medical school, and post-graduate levels. Several studies have demonstrated such findings. However, there are no studies to date that have gathered information regarding attitudes from medical students, reflecting their views about the field of sleep medicine. We aimed to survey medical students across the United States regarding their exposures and attitudes toward sleep medicine as a career.

Methods: A web-based survey was designed through the Mayo Clinic Survey Research Center. The survey contained twenty-two questions reflecting demographic information, specialty interests, career intentions, sleep medicine exposure during didactic and clinical training years with attention to specific rotations, presence of a sleep medicine rotation, presence of a sleep medicine mentor/role model, and presence of a sleep medicine interest group. The survey was electronically sent to deans of all allopathic and osteopathic medical schools across the United States with a request to forward the survey to their students. All survey responses were anonymous.

Results: 558 responses returned. 34 (7.3%) were considering sleep medicine as a career vs. 312 (67.1%) who were not and 119 (25.6%) who were unsure. Of those who were not or unsure, most were considering internal medicine, pediatrics, or emergency medicine. Those who were not considering sleep medicine were likely to be further along in medical school. In general, the amount of didactic or clinical exposure to sleep medicine did not affect career choice. The presence of a sleep medicine rotation did not affect career choice. Those who were not considering sleep medicine felt that mentoring/role modeling was influential in shaping their career choice ($p = 0.0001$). Those who were considering sleep medicine were more likely to have a sleep medicine mentor/role model in medical school ($p = 0.0178$). Those considering sleep medicine were slightly more likely to be Asian/Pacific Islanders.

Conclusion: In our small survey-based study, we found that a small number of medical students are considering sleep medicine as a career choice. This did not appear to be related to didactic or clinical exposure to sleep medicine or the presence of a sleep medicine rotation, but did appear to be related to having a sleep medicine mentor/role model.

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SLEEP SYMPTOMS AND HEALTH BEHAVIORS OF COLLEGE STUDENTS IN CENTRAL MEXICO

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Background: Sleep disorders and negative health outcomes have been well documented. Authors have pointed out the need to educate college

students on the importance of sleep and lifestyle choices. The purpose of this work is to describe sleep symptoms and health behaviors of college students in central Mexico.

Methods: A convenience sample of college students from physics and engineering programs voluntarily completed demographics and health behavior surveys, and a Spanish-language validated Sleep Habits Questionnaire after providing human subjects consent. Data were analyzed using SPSS software (V21).

Results: Of the student respondents ($N = 185$; 64% men; mean age and SD 20 ± 2 years), 25% were overweight/obese, 12% reported a family history of sleep problems, 5% had mental health problems, 1% reported CVD, and 25% indicated high rates of stress (8-9 on a 0-10 scale). Behavioral surveys showed 14% current smokers, 13% consumed 4 to 8 alcohol drinks/day, and 76% used electronic devices in their bedrooms. On average, students took 20 minutes to fall asleep, with a mean duration of 6 ± 2 hours during the week and 8 ± 2 hours on weekends. Prevalence of sleep symptoms were insufficient sleep (50%), non-restorative sleep (39%), sleep onset and early morning waking problems (17% each), inability to stay asleep (9%), and leg movements (6%) or cramps (4%) during the night. Of the sample, 42% reported frequent snoring that was more common among men than women (32% vs. 13%). Breathing pauses (10%) and physician-diagnosed OSA (1%) were also noted. The Epworth mean was 8.6 ± 4.4 with higher scores for women (9.6 ± 4.8) compared to men (8.0 ± 4.1 , $p < 0.05$) and a prevalence of 31% at Epworth scores > 10 .

Conclusions: High rates of sleep symptoms and snoring in tandem with lifestyle factors, including electronics usage in the bedroom, smoking and alcohol use underscore the need for sleep health promotion guidelines among college students in Mexico.

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NARCOLEPSY COMMUNITY'S RESPONSE TO FDA PATIENT-FOCUSED DRUG DEVELOPMENT INITIATIVE

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Introduction: In August 2012 the FDA announced that narcolepsy had been chosen as one of the twenty medical conditions in the innovative PFDDI. Narcolepsy was the only sleep related condition included in the program. This initiative represents a change for the FDA in that it allows the organization to hear directly from patients regarding whether their medical needs are being met and what impact the condition has on their lives. The narcolepsy community had seven weeks to prepare their responses once the forum date was announced. Narcolepsy Network (NN), a member-focused nonprofit organization, led the effort to ensure that the FDA would be well informed.

Methods: Awareness emails were sent to those in the Constant Contact database of NN. A total of 5,000 discrete addresses were contacted for a series of six emails over a seven week period. Additionally, targeted emails were sent to those contacts located within a 100-mile radius of Washington, DC.

Results: The FDA sought ten patient panelists to discuss specific questions on two general topics; over 60 patients agreed to participate on the panels. The FDA also had the capacity for 150 participants to be present on-site with an additional 500 webcast viewers. Registration for on-site participation was closed two weeks early due to capacity being reached. By the registration deadline, approximately 700 viewers had signed up for the webcast. FDA representatives called the response 'unprecedented.'

Conclusion: Narcolepsy is a commonly misunderstood chronic medical condition. Current pharmacological regimens treating excessive daytime sleepiness and aiding in sleep consolidation allow for some

improvement in the quality of life, but overall efficacy is still lacking. The narcolepsy community's impressive response to the FDA's quest for information should assist that organization in its direction and regulation of the pharmaceutical industry's efforts to develop novel therapeutic options for patients with this condition.

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SCANNABLE QR-CODED MEDICAL ALERT BRACELETS FOR PATIENTS WITH NARCOLEPSY

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Introduction: In June 2013 Jazz Pharmaceuticals released the findings of their AWAKEN (Awareness and Knowledge of Narcolepsy) survey. This survey examined the narcolepsy knowledge of 1,000 adults, 300 primary care physicians, and 100 sleep specialists. The surprising results were that only 24% of PCPs and 62% of sleep specialists considered themselves 'very or extremely knowledgeable' about the disorder. Only 22% of sleep specialists were able to identify all five symptoms of the disease; the same number reported they were 'not very or not at all comfortable' in diagnosing narcolepsy. These results, combined with anecdotal patient reports of suboptimal emergency department (ED) medical care, prompted us to design a QR-coded medical alert bracelet to be used by first responders and ED personnel to quickly obtain up to date information on medications used and practice parameters for the treatment of narcolepsy.

Methods: A medical information page was created on Narcolepsy Network's website (<http://www.narcolepsynetwork.org/narcolepsy-911/>) with links to webpages of common narcolepsy medications and a treatment review article. A QR code was generated for this information page and silicon medical alert bracelets were designed and produced. A similarly QR-coded wallet sized medical alert card was also developed and produced.

Results: At Narcolepsy Network's Annual Conference in October 2013, 184 of the bracelets and cards were distributed to patients with narcolepsy, including doctors and nurses. The response was overwhelmingly positive for the benefit these bracelets were expected to offer. Requests for the bracelets were quickly received from patients in locations as distant as Scotland and the Netherlands.

Conclusion: The rapid communication of essential medical information is requisite in order to provide optimal medical care. This is especially urgent when dealing with a patient with a poorly understood medical condition. The use of a QR-coded medical alert bracelet provides a facile method for transmitting this information.

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CHALLENGES IN DIAGNOSIS OF SHIFT WORK DISORDER IN PRIMARY CARE PRACTICE: PRACTICE GAPS IDENTIFIED FROM AN ONLINE, PATIENT SIMULATION.

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Introduction: Shift Work Disorder (SWD) is a circadian rhythm sleep disorder in which an individual's circadian rhythm and the work/sleep schedule are misaligned. It is diagnosed based on symptoms of excessive sleepiness and/or insomnia associated with the misaligned sleep schedule. SWD could be identified in primary care practices, yet remains significantly under-diagnosed and thus rarely addressed, posing a significant public health problem.

Methods: An accredited Continuing Medical Education (CME) program incorporating an online patient simulation was developed to determine experience, knowledge, competence, and performance in assessment and diagnosis of SWD. Utilizing a novel simulation platform, the case was designed to particularly assess skills in taking a sleep history including relevant symptom assessment. Complex branching logic personalizes experience and feedback, thus meeting individual needs and providing relevant information about the patient's symptoms and sleep schedule only when the appropriate selection(s) is made. Two mentors, a sleep specialist and a primary care clinician, provide adaptive feedback during case completion.

Results: Preliminary data from 444 participants revealed that 55% had diagnosed a patient with SWD. In taking a sleep history, utilizing questions relating to timing of sleep were least popular with 20% of participants totally omitting those questions prior to correction with adaptive mentor feedback. Of the 42% who chose the Epworth Sleepiness Scale as a symptom assessment tool, 41% reported that they were unfamiliar with the scale. Of the 92% opting to provide sleep hygiene guidance to the virtual patient, 25% reported being unfamiliar with sleep hygiene principles and a further 22% were not confident that sleep hygiene improves sleep disorders. More comprehensive data analyses will be provided in the final presentation.

Conclusion: These initial findings suggest that despite a high prevalence of SWD in primary care, there is a lack of understanding of basic sleep assessments and management of SWD. Providing standard assessments and resources with education programs without assessing learners' competence in their use may limit the positive impact on patient care.

Support (If Any): This educational program is supported by an independent medical education grant from Teva Pharmaceutical Industries Ltd.

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SU SUEÑO/SU VIDA: DEVELOPMENT AND EVALUATION OF A SLEEP TRAINING MANUAL FOR SPANISH-SPEAKING HEALTH PROVIDERS

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Introduction: Sleep disorders and negative health outcomes of Spanish-speaking Hispanics are emerging. Prevalence rates of snoring and other sleep symptoms underscore the need for educational materials regarding healthy sleep and sleep promotion. This work describes the development and testing of a sleep training manual for Spanish-speaking health providers in clinical, community-based and border settings.

Methods: A training manual that explicates leading sleep disorders (OSA, snoring, insomnia symptoms, short sleep duration, RLS) and sleep hygiene/stimulus control methods was developed by sleep experts and translated into Mexican Spanish by public/border health personnel at the PAHO/WHO U.S./Mexico Border Office in El Paso, Texas and health sciences faculty in central Mexico. Data included pre/post testing of learning with a group of health providers enrolled in a World Diabetes Foundation (WDF) Education Certification class in central Mexico and health providers not involved in the development and translation at the PAHO/WHO office in El Paso, Texas. Data were analyzed with paired t-tests using SPSS (V20) with significance set at $p < 0.05$.

Results: The WDF group (N = 34; 91% women) consisted primarily of physicians, nutritionists and mental health workers. Their mean scores with standard deviations showed significant differences in learning concepts from pre- (8.7 ± 1.04) and post-testing (9.7 ± 0.59 , $p < 0.0001$). The PAHO/WHO group (N = 12; 83% women) was comprised primarily of public health and health educator specialists, physicians and mental health workers. Significant differences were also noted for the PAHO/WHO group pre- (8.3 ± 1.06) and post-testing (9.7 ± 0.49 , $p < 0.001$). Errors on pre-test items were consistent between groups.

Conclusion: Testing of health providers in central Mexico and the U.S./Mexico Border Office showed significant pre-to-post learning regarding sleep disorders and sleep health promotion strategies. Similarities between groups in pre-test item errors suggest need for learning in the areas of daytime napping, RLS and insomnia unrelated to depression rather than any differences in Spanish-translation between regions.

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IS THERE AN ASSOCIATION BETWEEN ACCESS TO NATURAL AMENITIES AND SUFFICIENT SLEEP? RESULTS FROM THE 2010 BRFSS

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Introduction: Emerging empirical evidence suggests exposure to natural amenities (e.g., green-space, oceanfront) may improve health behaviors and mental health outcomes such as increased levels of physical activity and lower levels of depression associated with sleep quality. Little is known about the relationship between self-reported sufficient sleep and natural amenities.

Methods: A subsample (n = 253,550) of the US 2010 Behavioral Risk Factor Surveillance System, a randomized survey of risk factors among US adults ≥ 18 years of age, was used to examine the association between self-reported sleep sufficiency (the number of days individuals indicated as having sufficient sleep in the past month) and access to natural amenities. Participants with geographically referenced data were assigned an amenity score based on an index developed by the United States Department of Agriculture to reflect the natural landscape of counties including varied topography such as lakes, ponds, oceanfront, and climate to encompass all four seasons in the US (i.e., winter, spring, summer, fall). Multiple linear regression was performed in STATA 12 to explore the relationship between subjective sleep sufficiency and natural amenities.

Results: Higher number of days with sufficient sleep were positively associated with higher scores for natural amenities ($\beta = 0.112$, $P = 0.05$), controlling for age, gender, race, marital status, education, employment status, income level, physical activity, body mass index and asthma. Days with sufficient sleep were negatively associated with Hispanic ethnicity ($\beta = -1.418$), increased age ($\beta = -0.081$), higher levels of education ($\beta = -0.411$) and a propensity to snore ($\beta = -0.388$) (all $P \leq 0.00$).

Conclusion: In a nationally representative sample of US adults, access to natural amenities was shown to attenuate the risk for insufficient sleep. Additional studies may be needed to determine whether this relationship holds at smaller levels of geography and to disentangle whether specific characteristics of the natural environment may be more likely to improve sleep sufficiency.

Support (If Any): This study was funded in part by research funds from the Department of Kinesiology and Community Health at the University of Illinois at Urbana-Champaign as well National Institutes of Health/ National Heart, Blood, and Lung Institute grant #7R25HL105444-04.

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EXPERIENCE OF DAILY VERSUS LIFETIME PERCEIVED DISCRIMINATION: PREDICTION OF SLEEP QUALITY IN A POPULATION-BASED SAMPLE

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Introduction: Recently, stress in the social environment has been implicated in sleep disturbance. Perceived discrimination is an environmental and sociopolitical stressor that could negatively impact sleep. Discrimination can be measured across multiple timescales such as on a daily basis or accumulation across a lifetime. The current study investigated the relative contribution of daily versus lifetime perceived discrimination in the prediction of subjective and objective sleep outcomes in a population-based sample.

Methods: An archival analysis was conducted with 312 adults (Mean = 54.66, SD = 12.05) participating in the Midlife in the United States-II study. Perceived daily and lifetime discrimination were assessed with self-report questionnaires. Sleep diary and actigraphy data were collected across seven days. Sleep diary variables consisted of sleep onset latency, perceived difficulty falling asleep, number of awakenings, and sleep quality rating. Actigraphic variables included: sleep onset latency, wake after sleep onset, and sleep efficiency. Hierarchical regression analyses were conducted with covariates entered at step one and perceived discrimination variables entered at step two.

Results: Daily, not lifetime, perceived discrimination significantly predicted perceived difficulty in falling asleep, $\beta = .18$, $F(7, 304) = 6.86$, $p < .001$, and sleep quality ratings, $\beta = .18$, $F(7, 304) = 10.80$, $p < .001$, after controlling for age, sex, racial origins, education, and depressive symptoms. Neither discrimination variable predicted Actigraphic sleep outcomes.

Conclusion: Consistent with sleep being a daily process, the daily experience of perceived discrimination predicted sleep outcomes while the lifetime experience did not. The results highlight the importance of using concordant timescales of measurement and the more robust role of proximal versus distal influences on sleep. Interestingly, discrimination predicted subjective, not objective sleep outcomes. The subjective experience of sleep may be particularly important to consider when investigating the role of social environmental factors in sleep outcomes.

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THE ASSOCIATION OF SAFETY IN NEIGHBORHOOD AND HOME WITH SLEEP QUALITY IN A LATIN AMERICAN COUNTRY

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Introduction: Neighborhood social and physical environments have been linked to cardiovascular risk factors such as diabetes, hypertension, and obesity. The mechanism by which neighborhood impacts health risk is not completely clear. One possibility is that the effect may be mediated through effects on sleep. An unsafe neighborhood environment may

create feelings of insecurity impairing the ability of residents to initiate and/or maintain sleep. We sought to assess the impact of feelings of safety in one's neighborhood and home on sleep quality.

Methods: A cross-sectional survey with a face-to-face interview was conducted in October 2012, as part of the Argentine Social Debt Barometer (ASDB). ASDB reflects nationwide data from 5,636 participants aged 18 years and older about different aspects of their life including sleep. The relationship between subjective sleep quality [SQ] (rated 1-4) and both neighborhood and house safety (feeling safe/unsafe) was analyzed using multivariate linear regression. Age, gender, neighborhood socioeconomic status, education and employment status were included as covariates.

Results: The prevalence of poor sleepers ($SQ \leq 2$) was 15.5%. A total of 51.0% felt unsafe in their neighborhood and 27.9% felt unsafe in their home. Feeling unsafe in one's neighborhood was strongly associated with poorer SQ ($Beta = -0.075$, $p < 0.001$) in multivariate analyses. The effect size was similar in magnitude to having a high school diploma ($Beta = 0.074$, $p < 0.001$) and almost twice in magnitude to being female ($Beta = -0.041$, $p = 0.004$). In contrast, the effect of feeling unsafe in one's own home was only two thirds as great ($Beta = -0.05$, $p = 0.002$).

Conclusion: Our findings suggest feelings of safety may promote improved SQ. While both a sense of safety in one's home and one's neighborhood are associated with improved sleep, neighborhood safety appears to have a stronger impact. Further research is warranted to assess whether interventions addressing safety can be used to improve sleep and overall health.

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SLEEP DURATION AND UNEMPLOYMENT STATUS DURING 2008 ECONOMIC RECESSION

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Introduction: The associations between pattern of sleep duration and the rise in unemployment rate during the economic recession of 2008 have not been fully investigated. In this study, we examined whether the duration of sleep in the population was affected by concurrent rise in unemployment during the economic recession of 2008.

Methods: This study used data from three years (2007, 2009 and 2011) of the National Health Interview Survey (NHIS) obtained from the website of Integrated Health Interview Series of the U.S. National Health Interview Survey (Minnesota Population Center). Adults 18 or older were included in the study. The primary outcome was sleep duration. Sleep duration in whole numbers was ascertained by the answer to the question: "On average, how many hours of sleep do you get in a 24-hour period?" Unemployment rate for each calendar year was used as reported by the Bureau of Labor Statistics of the U.S. Department of Labor. Sleep duration was divided into 5 groups: ≤ 5 hours, 6 hours, 7 hours, 8 hours and ≥ 9 hours. Sleep duration of 7 and 8 hours is considered normal. Chi-square test was used to analyze the difference in sleep duration categories across the years (2007, 2009, and 2011).

Results: Unemployment rate in the years 2007, 2009 and 2011 was 4.6%, 9.3% and 8.9% respectively. Sleep duration significantly decreased from 2007 to 2009 for 7 hours (31.2% to 29.68%, p -value 0.0002) and 8 hours (32.75% to 31.9%, p -value 0.0423) categories. Similarly sleep duration increased from 2007 to 2009 in the ≤ 5 hours (7.7% to 8.57%, p -value 0.0004) and for ≥ 9 hours (8.39% to 9.34%, p -value 0.0002). There was no significant difference in the 6 hour duration. Sleep duration did not significantly changed from 2009 to 2011 for all groups except for ≤ 5

hours where it increased significantly (8.57% to 9.03%, p -value 0.0462). Sleep duration in all groups have remained significantly different when compared from 2007 to 2011.

Conclusion: Sleep duration may be associated with economic recession of 2008 and rise in unemployment rate. Further studies are needed to evaluate this relationship.

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ASSESSING TREATMENT GAPS FOR THE UN- OR UNDERINSURED PATIENTS THROUGH COMMUNITY PARTNERSHIPS: A POTENTIAL IDEA FOR COST EFFECTIVE CARE

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Introduction: The management of obstructive sleep apnea (OSA) in patients who cannot afford a CPAP device is challenging. Some charity organizations provide CPAP for uninsured patients but little is known about unique factors that affect adherence. We hypothesize that additional factors besides the ability to purchase CPAP may uniquely affect adherence in uninsured patients.

Methods: CPAP devices were provided through an ASMF Humanitarian Grant to 30 uninsured patients, with OSA by Medicare criteria (group 1). 25 other uninsured patients with OSA (group 2) were provided contact options to obtain CPAP (local and national charity organizations, discounted or used CPAP). Both groups were followed at 3 months (further follow-up in process). Factors potentially affecting adherence included: timely acquisition, phone access, ability to come to the appointment (transportation), available electricity, discomfort due to mask or pressure and other medical conditions.

Results: There were no significant differences between groups in gender (Group 1: 18 women, 12 men vs Group 2: 14 women and 11 men), age (47.7+9.4 [mean+SD] vs 46.4+10.7 yr), AHI (AHI 33.2+34.9 vs 37.3+38.2/hr) or CPAP pressure (12.6+3.6 vs 12.8 \pm 3.6 cmH₂O). At 3-months, all Group 1 patients had received CPAP and 13 had returned for follow-up. 12 patients from group 2 had obtained CPAP devices and only 6 returned for follow-up. Factors that impeded follow-up included phone disconnection, not returning phone calls, incarceration, no transportation, comorbidities and relocation.

Conclusion: The provision of CPAP devices to uninsured populations alone may not solve adherence problems. Other socioeconomic factors need to be assessed in such patients who already have high health care risks, and may need to be taken into consideration for charity programs to be effective

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THE "OPT-OUT" RECRUITMENT STRATEGY IN THE SNORE STUDY: OUTCOMES AND PARTICIPANT PERSPECTIVES

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Introduction: The "opt-out" recruitment strategy is ideal for scientifically sound and generalizable studies. However, potential subjects' perspectives on this method of contact are unknown. We report outcomes and participant perspectives of an IRB-approved "opt-out" recruitment strategy as part of the SNORE Study, an ongoing prospective study of sleep apnea and kidney disease.

Methods: We identified veterans age 18-89 in the NF/SGVHS (2/12/2012-present) with ≥ 2 eGFRs between 15-44; target enrollment = 250 over 2 y. After receiving permission from PCPs, we invited eligible veterans in random order to participate via letter with follow-up call within 1 week for non-response. Letters referenced the PCP and provided a 1-800 number and email to facilitate communication. Beginning 7/22/2013, we queried participants and potential recruits about their perceptions of this method of contact: Q1) "How comfortable were you with our method of reaching you." and Q2) "If we called you first, were you comfortable with us calling you?" on a scale of 0-10, with 10 = most comfortable and 0 = not at all.

Results: To date 1,101 letters have been mailed. 249 veterans called in; we contacted the remaining 852 veterans. Overall, 637 were not interested, 147 scheduled visits, 111 were interested but not now, and 206 could not be reached. Of those who scheduled a study visit, 66% completed enrollment (n = 95), 11% plan to reschedule, 21% cancelled. On average, 3-4 visits occur each week. 77 potential recruits were asked Q1; 71 responded (mean comfort level = 8.5 ± 2.0). 45 participants were asked and responded to Q1 with mean comfort level = 9.8 ± 0.5 . For Q2, 44/45 participants responded; their comfort with our calling them was high (mean = 9.5 ± 1.8).

Conclusion: An "opt-out" recruitment strategy with PCP approval and easy "opt-out" options met IRB expectations and yielded adequate enrollment numbers. In addition, participants and potential recruits appear to be comfortable with this method of recruitment.

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1094

COMPARISON OF AMERICAN ACADEMY OF SLEEP MEDICINE (AASM) VERSUS MEDICARE (CMS) SCORING RULES ON AHI AND ELIGIBILITY FOR THERAPY IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Recent AASM rules (2012) for scoring hypopneas differ from those of CMS. For hypopneas CMS requires a 4% oxygen desaturation, whereas AASM allows for 3% desaturation or terminal arousal. Since the two systems may give different severity estimates, we determined the extent to which patients with obstructive sleep apnea (OSA) would be eligible for Positive Airway Pressure (PAP) treatment under each scoring system.

Methods: We retrospectively reviewed PSG results and patient charts in 39 subjects in whom hypopneas were scored using both the AASM and CMS scoring rules. We evaluated their correspondence for an apnea-hypopnea index (events/hour; AHI) > 15 , and for eligibility for CPAP per CMS criteria (AHI 5-15 with certain co-morbidities: hypertension, mood disorder, ischemic heart disease, cognitive disorder, stroke or excessive daytime sleepiness). For both AASM and CMS scoring rules, we defined eligibility for CPAP as: 1) AHI > 15 , or 2) AHI 5-15 plus certain one of the co-morbidities.

Results: Age was 51.8 ± 14.1 y, BMI was 33.3 ± 10.4 kg/m², median AASM AHI was 22.8, median CMS AHI was 10.2. Seven patients (18%) did not qualify for CPAP under either system. Twenty-five patients (78.1%) had AHI > 15 and 7 had AHI 5-15 but qualified for PAP based on having a CMS recognized co-morbid condition). Using CMS AHI scoring rules 22/32 (68.7%) were eligible for PAP therapy and titration (15 having AHI > 15 and 7 having AHI 5-15 with a recognized co-morbid diagnosis). Thus, 10/32 (31.2%) patients would have been eligible for treatment using AASM AHI but not using CMS AHI. Age and BMI did not predict whether patients qualified under both criteria for CPAP.

Conclusion: Using CMS criteria for defining hypopneas, results in lower AHI and would exclude coverage for CPAP in almost one third of patients with OSA.

1095

IMPACT OF AUTOMATED EDUCATIONAL AND FOLLOW-UP MECHANISMS ON PATIENT ENGAGEMENT IN THE MANAGEMENT OF OBSTRUCTIVE SLEEP APNEA

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Introduction: Cost-effectiveness of medical care can potentially be enhanced by utilizing automate mechanisms to provide patient education and assist in follow-up care. We explore the impact of interactive web based educational programs (Web Education) to assist in patient education, and interactive voice response surveys (IVR) to assist in follow-up of patients newly initiated on CPAP therapy for obstructive sleep apnea (OSA).

Methods: We pseudo-randomized patients with suspected OSA appropriate for home testing into: 1) Traditional Management based on office encounters with case-managers (OSA class, home sleep testing, home CPAP trial, and 3 month follow-up) and 2) Telemedicine Management which utilizes the same sequence of office encounters but pre-educates patients with "OSA" Web Education prior to initial OSA class and with "CPAP" Web Education in those that test positive for OSA during their home CPAP trial; in patients prescribed CPAP for long-term therapy, automated IVR survey is telephoned to patients 4 times in 3 months asking questions regarding CPAP use. Three-month CPAP use was compared between the two groups.

Results: At time of interim analysis, 1406 (676 Telemedicine; 735 Traditional) patients were scheduled for OSA class. "No show" rate to initial OSA class was significantly lower in Telemedicine group (30% vs. 40%; p = 0.0001). Proportion of patients with OSA agreeing to long-term CPAP therapy were similar (92.8% vs. 84.4%; p = 0.14), while percentage of patients adherent with keeping their 3 month follow-up appointment (51.1% vs. 45.2%; p = 0.55) was also similar. Of the patients with 3 month follow-up (n = 46 vs. 33), mean CPAP use was significantly higher in the Telemedicine group (4.6 ± 2.0 vs 3.5 ± 1.8 hours; p = 0.02). Rate of viewing "OSA" Web Education program was 50% and "CPAP" program was 10%. 91% of patients completing 3-month follow-up responded to at least 1 IVR call.

Conclusion: Our interim analysis demonstrates that automated educational and follow-up mechanisms improve patient engagement with improved adherence to initial evaluation and to CPAP use, even though patient utilization of the automated programs was incomplete.

Support (If Any): Emmi Solutions supported this study by providing Interactive Voice Response calls.

1096

WIRELESS TELEMONITORING USES LESS STAFF TIME TO ACHIEVE ACCEPTABLE CPAP ADHERENCE

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Introduction: New methods to improve CPAP adherence are needed. The current study was based on a patient-centered, collaborative care model, which focused on providing the right treatment at the right time to patients with chronic illnesses (e.g., sleep apnea) and examined a wireless telemonitoring intervention and a self-management intervention.

Methods: The study was designed as a randomized, controlled clinical trial of one control group (Usual Care) and three interventions: individualized Self-Management (SM); Telemonitored Care (TC); and Combined Care (Self-Management plus Telemonitored Care) (TC+SM). The UC group was characterized by a one-week phone call and one-month clinic visit (at which time CPAP data was downloaded and reviewed). The TC group was characterized by the use of a wireless data modem to transmit CPAP data daily, allowing staff to proactively intervene.

Results: 280 patients diagnosed with OSA and prescribed CPAP therapy were studied (UC: 73; TC: 67; SM: 65; TC+SM: 75). There were no baseline differences in age, AHI, BMI, or sleepiness scores (ESS) between the groups. Nightly CPAP adherence measured over the three-month period was 3.2 ± 2.3 , 3.7 ± 2.3 , 3.7 ± 1.8 , and 3.7 ± 2.2 hours per night (mean \pm SD; $p = 0.50$). The number and duration of clinical contacts were measured for each encounter, with groups differing on total number of contacts (3.1 ± 1.5 , 4.2 ± 2.7 , 3.2 ± 1.9 , and 3.7 ± 2.1) ($p = 0.009$) and on total number of minutes of contact (78.4 ± 40.9 , 64.8 ± 54.9 , 127.7 ± 42.5 , and 130.3 ± 54.6 minutes) ($p < 0.0001$). All data for UC, TC, SM, and TC+SM groups, respectively. The ratio of mean adherence (hours/night) per 1 hr of clinical contact was calculated, with the TC group being most "efficient" (5.9 hrs of CPAP use per night for each 1 hour contact time).

Conclusion: Wireless telemonitoring resulted in acceptable CPAP adherence, but appeared to use staff resources more efficiently than other tested interventions including usual care and a defined self-management protocol.

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1097

ARIPRAZOLE: ANOTHER OPTION FOR THE TREATMENT OF RESTLESS LEGS SYNDROME

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Introduction: Restless legs syndrome (RLS) is characterized by uncomfortable limb sensations with an urge to move them, which can cause significant sleep disruption. The cause of RLS is unknown, but dopamine hypo-function in the striatonigral and spinal dopaminergic systems is implicated based on its response to dopaminergic agents. Antipsychotics act by blocking D2 dopamine receptors and can cause RLS. Interestingly, the atypical antipsychotic aripiprazole, which possesses partial D2 agonist activity, may have a role in treating RLS.

Report of Case: A 67-year-old man with depression on bupropion fulfilled RLS Study Group Diagnostic Criteria for RLS. Physical examination and serum ferritin were normal. Polysomnogram revealed an elevated periodic limb movement index. The patient was initially treated with ropinirole, then pramipexole, gabapentin, and lorazepam, all ineffective. Aripiprazole 2 mg was added for depression and significant improvement of RLS symptoms occurred. Subsequently, ropinirole was discontinued with sustained improvement of RLS. After a few weeks aripiprazole was discontinued and RLS symptoms returned. The patient resumed aripiprazole and again RLS symptoms improved.

Conclusion: Aripiprazole is an atypical antipsychotic with partial agonism at D2 receptors. A few case reports describe significant improvement in RLS symptoms with introduction of aripiprazole. In some cases return of RLS symptoms occurred with cessation of aripiprazole, just as we observed. Given its unique mechanism of action and growing anecdotal benefit in RLS, aripiprazole may be particularly useful in patients with comorbid RLS and psychiatric indications for antipsychotic medications. Our case provides further evidence prompting more study of aripiprazole for treatment of RLS.

1098

NARCOLEPSY: A SEQUELAE OF ELECTRICAL INJURY

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Introduction: Electrical injury is known to occur from nature in the form of lightning as well as man-made power sources. Electricity flows through the path of least resistance, nerve cells having the lowest resistance. Burns, cardiac arrhythmias, peripheral nerve injuries, and seizures have been reported. Neurologic sequelae of electric injury could be immediate/transient or prolonged/permanent but to best of our knowledge, electrical injury resulting in hypersomnia of central origin or narcolepsy has not been reported.

Report of Case: A healthy 19-year-old male was working in a machine shop. He was cleaning industrial machines and unplugging them. In the process, he was electrocuted with 440 V of electricity. He experienced an excruciating headache and lost consciousness temporarily. After an emergency room evaluation, he was released, but subsequently began having daytime sleepiness worse in the early afternoons. He began having difficulties with fatigue, concentration, and focusing on daily tasks. Symptomatic treatment with stimulants was initiated but without much improvement in his hypersomnolence. He was sleeping 14 hours per day with 1-2 hours of naps in the daytime. He described hallucinations of falling with jerks in his legs as he would try to go to sleep. He underwent a multiple sleep latency test which showed evidence of hypersomnia with a mean latency of sleep of 3 minutes and 3 sleep onset REM periods. His prior night study did not show obstructive sleep apnea and

his AHI was 3.5. Modafinil treatment was initiated with significant improvement in hypersomnolence.

Conclusion: This is the only case to our knowledge illustrates an example of hypersomnia following an electrical injury which on testing had findings on MSLT consistent with narcolepsy. This merits further follow up to ascertain if hypersomnia is common in cases with electrocution and whether this is immediate/transient, chronic/permanent or both.

1099

WHEN SLEEPINESS CHANGES: A CASE OF KLEINE-LEVIN SYNDROME EVOLVING INTO PERSISTENT HYPERSOMNIA

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Introduction: Kleine-Levin Syndrome (KLS) is a rare form of periodic hypersomnia, associated with behavioral abnormalities (hyperphagia, polyphagia, hypersexuality), depression, irritability and cognitive impairment. Between episodes, patients are typically asymptomatic. We report a case of KLS in which periodic symptoms progressed to a more persistent hypersomnia state.

Report of Case: A 57-year-old male presented to an academic sleep disorders center for follow up of KLS. He had been diagnosed with KLS 22 years previous, with a classic presentation of periodic hypersomnia associated with hyperphagia, altered food craving, irritability, and excessive masturbation. Between episodes, he was asymptomatic. Typical episodes were 3-14 days in duration, at a frequency of twice to thrice yearly. Over the years, multiple medications were prescribed to address the hypersomnia, including methylphenidate, amphetamine, modafinil, lithium, and, most recently, clarithromycin, all without success. For the past three years, the hypersomnia symptom had gradually become more persistent, evolving to ultimately affect him nearly constantly. Subsequent overnight polysomnography revealed the presence of obstructive sleep apnea, with an apnea hypopnea index of 30 per hour of sleep. Magnetic resonance imaging revealed an old infarction involving the right pallidum, with extension into the thalamus. Diffusion tensor imaging reconstruction of the fiber tracts demonstrated absent connectivity between the pallidum/antero-basal thalamus and the cortex, supporting a contribution to central hypersomnia.

Conclusion: Hypersomnia is a complex symptom which may arise from multiple sources within the same patient. In this case, a change from periodic to persistent hypersomnia suggested a possible mechanistic alteration, allowing the diagnosis of two new contributors to daytime sleepiness: OSA and thalamic stroke. This case demonstrates the importance of close follow-up for patients with known sleep disorders, using a patient-centered, symptom-based approach. Clinicians should be vigilant to monitor for changes from usual patterns of disease, in order to prevent missed opportunities for effective interventions.

1100

TREATMENT OF HIGH ALTITUDE ASSOCIATED SLEEP DISORDERED BREATHING WITH ADAPTIVE SERVO VENTILATION (ASV)

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Introduction: Central apneas in the form of periodic breathing can be seen at high altitudes. Central apneas seen at high altitudes are often seen with Cheyne Stokes morphology. We describe a case of central apnea due to high altitude effectively treated with ASV.

Report of Case: A 53-year-old male with obstructive sleep apnea (OSA) became symptomatic while using his bilevel positive airway

pressure (BPAP) machine and was found to have frequent central apneas while vacationing at an elevation of 7,000 feet. He experienced headaches and difficulty breathing despite use of his BPAP. His data download during that period demonstrated a central apnea index of 82-98. Interestingly it did not recognize it as periodic breathing. Titration with adaptive servoventilation was performed at an elevation of 840 feet which recommended settings of maximum pressure 25, minimum EPAP 5, maximum EPAP 9, pressure support minimum 0 and maximum 10 and auto backup rate. Subsequently the patient traveled to an elevation of 5,900 feet and 4,300 feet. At both locations he used his ASV machine compliantly and asymptomatic during that period. Data download during those travel days was much improved with a central apnea index of 1 and 0.9, respectively. Given these observations and clinical improvement, the patient was recommended to use ASV with his frequent trips to high altitude.

Conclusion: This case shows that ASV may be an effective treatment for patients with central apneas associated with high altitude but evidence behind its use is lacking. This case also suggests that an ASV setting prescribed upon evaluation at or near sea level would be effective when used at a high altitude. Data download is a useful tool in detecting central apneas during travel to high altitude, as well as demonstrating the efficacy of ASV.

1101

A CASE OF CPAP RESPONSIVE EXPLODING HEAD SYNDROME (EHS)

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Introduction: Exploding head syndrome (EHS) is a rare, benign parasomnia, characterized by painless, loud terrifying noise inside the head at the onset of sleep that wakes the patient, without a true headache. This rare phenomenon was initially reported by Armstrong-Jones in 1920 and termed "exploding head syndrome" in 1989 by Pierce. We describe a case of EHS in which CPAP diminished the frequency of the events.

Report of Case: A 35-year-old-man was referred for symptoms of obstructive sleep apnea (OSA). He also described a brief, painless, loud noise in the head, as he falls asleep. The noise always wakes him, and he has clear recollection of the events. Polysomnogram revealed moderate OSA (RDI 29.5) and frequent epochs of REM sleep with elevated phasic leg EMG tone, consistent with REM without atonia. Patient was treated with Auto-PAP 16-20 cmH₂O. On follow-up, patient reported significant improvement in frequency of EHS events from almost nightly to less than weekly on PAP therapy.

Conclusion: The mechanism of EHS is unknown, but symptoms are thought to occur during transition from wakefulness to sleep. It is very disruptive for the patient and can cause sleep onset insomnia. Differential diagnosis includes nocturnal headache syndromes and seizures. Although no specific treatment is available, there exists some anecdotal evidence favoring clomipramine, clonazepam, nifedipine, and topiramate. Our case is interesting as our patient had significant improvement in the frequency of the events after sleep apnea was treated with CPAP. Limited prior data exists in the form of a case report suggesting that treatment of even mild underlying sleep apnea can result in improvement in EHS. OSA is associated with sleep fragmentation and frequent arousals and we hypothesize that, because EHS is a disorder that occurs during sleep-wake transitions, by consolidating sleep with CPAP therapy, it reduces occurrence of EHS symptoms.

1102

SEMOLOGIC SIMILARITIES BETWEEN SLEEP RELATED EPILEPSY (SRE) AND SLOW WAVE PARASOMNIA: A DIAGNOSTIC CHALLENGE

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Introduction: Complex motor behaviors in sleep are not an uncommon presenting complaint in sleep disorders clinics. It can be a challenge for even an experienced sleep specialist as differential diagnosis is wide in most cases.

Report of Case: A 24-year-old otherwise healthy female presented with 3-year history of frequent witnessed nocturnal events, non-refreshing sleep and daytime fatigue. She typically would "jolt up" from sleep with a panic and would look around confused before becoming aware of the surroundings. These episodes were typically brief, occurring in 2nd half of night and she reported "out of body experiences like feeling foggy". Often she would be seen to mumble by her boyfriend. At the time of presentation they were occurring few times each night. She denied sleep disordered breathing symptoms. FLEP scale score was +4. Polysomnogram performed with 16 lead EEG and parasomnia montage did not show OSA and multiple typical events were recorded occurring mostly out of N2 and N3 sleep. Review of the EEG did not reveal any clear epileptiform discharges during the events. Trial of Klonopin for N3 parasomnias was initiated without clinical improvement. MRI of brain was normal. Subsequently patient was started on Keppra, an anticonvulsant with a presumptive diagnosis of nocturnal seizures. It resulted in resolution in her episodes. Later video-EEG monitoring captured multiple episodes with clear epileptiform discharges from the right temporal region.

Conclusion: This case signifies SRE can closely mimic NREM parasomnias. Often in SRE there is lack of clear epileptiform discharges even during the clinical event. Video EEG monitoring is an alternative and likely has a higher diagnostic yield. FLEP scale was more suggestive of frontal lobe epilepsy as compared to parasomnia and can be good clinical tool for initial assessment in these cases.

1103

ABSENCE OF SIGNIFICANT OBSTRUCTIVE SLEEP APNEA SYNDROME IN A 10 YEAR OLD WITH A NECK MASS AND TRACHEAL NARROWING

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Introduction: Numerous case reports describe secondary obstructive sleep apnea syndrome (OSAS) in association with retropharyngeal lipoma, aryepiglottic cyst, carotid body tumor, lingual thyroid, head and neck rhabdomyoma, and parapharyngeal masses, due to mechanical compression of the upper airway. We describe a case of an extensive head and neck lymphatic-venous malformation causing thoracic tracheal narrowing, which did not cause significant OSAS, despite high clinical suspicion.

Report of Case: A 10-year-old boy with a massive congenital cervicothoracic and intrathoracic lymphatic-venous malformation was referred for evaluation of possible sleep disordered breathing. The patient had been treated with sildenafil 20 mg PO tid for the past year, with no significant reduction in tumor bulk. His parents noted that he had nocturnal snoring for the past 4 months, however there had been no witnessed apneic episodes, complaints of daytime somnolence, hyperactivity or other clinical symptoms of OSAS. The pertinent physical examination demonstrated a massive, soft, non-tender, multi-lobulated mass extending from the left mid lateral cheek, periorbital region and ear to the mid chest wall and to the right posterior aspect of his neck. An MRI of the chest showed a massive trans-spatial venolymphatic malformation of the neck and upper chest, causing thoracic tracheal narrowing. The polysomnogram revealed

a pediatric obstructive apnea/hypopnea index of 2.0 events/hour of sleep, no sleep fragmentation, and oxygen saturations were well above 88%.

Conclusion: Significant thoracic tracheal compression caused by massive head and neck lymphatic-venous malformation did not result in significant OSAS. This suggests that the pretest probability for OSAS is low in patients with head and neck masses which cause mechanical compression of the upper airway, unless there are associated clinical symptoms of sleep disordered breathing.

1104

DIAGNOSIS OF OCCULT SLEEP APNEA IN A 14 YEAR OLD WITH POMPE'S DISEASE

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Introduction: Pompe's disease is an autosomal recessive type II glycogen storage disease, characterized by an acid maltase enzyme (α -glucosidase) deficiency secondary to mutations in the acid α -glucosidase (GAA) gene. This results in impaired metabolism of glycogen, causing toxic accumulation in lysosomes with resultant damage to skeletal muscles, the cardio-pulmonary system, and a high risk for fatal respiratory failure.

Report of Case: A 14-year-old female diagnosed with Pompe's disease at the age of seven, currently treated with biweekly α -glucosidase infusions is presented. On exam, she has proximal muscle weakness, mild neck weakness, a waddling gait with difficulty in heel-to-toe walking, and trouble rising from a sitting position. She presented to the Sleep Medicine clinic, denying symptoms of snoring, apneic episodes, or nighttime awakenings. She sleeps at least 10 hours and wakes up feeling refreshed. There is no daytime sleepiness or other clinical signs or symptoms suggestive of sleep apnea. She underwent tonsillectomy at age 11, due to obstructive sleep apnea. Another diagnostic polysomnogram was performed at age 14, due to concerns of neuromuscular weakness. This was consistent with moderate to severe pediatric obstructive sleep apnea with a pediatric obstructive apnea/hypopnea index (OAH) of 8.1 events/hour and a REM supine OAH of 32 events/hour, with an oxygen nadir of 84% and visibly increased work of breathing.

Conclusion: Patients with Pompe's disease can present without symptoms of sleep disordered breathing despite significant hypoventilation, hypoxemia, and apneic events. The atonia of REM sleep provides a further mechanical disadvantage and significantly increases the severity of sleep disordered breathing. An overnight polysomnogram is essential to diagnose the effects of neuromuscular weakness on respiration, including hypoventilation, hypoxemia, and apnea. Bi-level pressure is the recommended treatment, to decrease the risk of atelectasis, infections, aspiration, and ischemic injury to other organs.

1105

EFFECTIVE IMPLEMENTATION OF COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA (CBTi) FOR PATIENTS RESISTANT TO THERAPY

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Introduction: CBTi is well-established as an efficacious treatment for insomnia; however, its effectiveness is dependent on the patient's attitude towards therapy. This case study is an example of successful implementation of CBTi with a highly resistant patient initially skeptical of the utility of treatment who later achieved treatment gains after therapy was appropriately adapted.

Report of Case: The patient, a 69-year-old Caucasian male with well-controlled apnea, diabetes, and renal dysfunction, was referred to an out-

patient behavioral sleep medicine clinic for difficulty maintaining sleep. He was diagnosed with primary insomnia following evaluation and CBTi was implemented, including sleep hygiene, stimulus control, sleep restriction, brief relaxation, and cognitive therapy. Initially, the patient was vociferously skeptical and critical of CBTi techniques. He resisted implementing stimulus control and cognitive therapy, stating that he did not experience emotions. When his rationalizations were challenged, he became defensive and exhibited narcissistic personality traits (e.g., tangential anecdotes about outsmarting others, questioning the therapist's clinical expertise). Working alongside his skepticism and analytical approach to problem-solving, attention was given to explaining the physiological rationale behind the behavioral techniques and cognitive therapy was discontinued. As he began implementing strategies consistently, he observed gradual improvements in overall sleep. This attenuated his skepticism and he became more enthusiastic and compliant with the behavioral approaches. After six therapy sessions, he reported significant improvements in sleep quality and sleep consolidation (baseline 14-day sleep diary data: WASO = 198, sleep-efficiency = 59.84%; post-treatment: WASO = 16 minutes, sleep efficiency = 90.17%). PSQI and ESS scores dropped to non-clinical levels post-treatment. He acknowledged his initial skepticism and expressed surprise and satisfaction with sleep outcomes at treatment termination.

Conclusion: This case illustrates that even patients who are initially highly skeptical of CBTi can achieve treatment gains, though adapting therapeutic techniques may be warranted. Providers should not be deterred from utilizing CBTi for resistant patients whose diagnoses are appropriate for this treatment.

1106

NOCTURNAL SEIZURES PRESENTING AS PARASOMNIA

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Introduction: Sleep disorders can mimic, cause, or even be triggered by epileptic phenomena. Nocturnal seizures are routinely misdiagnosed as psychiatric problems or disorders of arousal.

Report of Case: A 26-year-old male presented with the chief complaint of somnambulism since childhood, noting that over the past several months he had begun to experience disturbing nightmares. The content of these nightmares often involved him being attacked. He described one such episode during which he "fought back," and unknowingly punched and kicked his girlfriend several times during his sleep. As a result she sustained a black eye and a concussion. He could not identify any inciting triggers to this change in his sleep-related behaviors. These episodes tended to occur in the early hours of the morning. He generally had very good recall of the dream content. He denied any prolonged confusion or disorientation upon awakening. He denied any history of seizures, febrile convulsions, or head injury. A 2-night baseline polysomnogram with full EEG and parasomnia montage was ordered, along with a MRI of the brain. MRI revealed no significant abnormalities. Baseline polysomnogram showed no evidence of sleep-disordered breathing and no abnormal elevations in EMG tone were seen during REM sleep. The 16-lead EEG demonstrated interictal abnormalities in the C3, C4, P3 and F4 regions. These abnormalities were suggestive of an interictal expression of a localization-related epilepsy with foci in the bilateral central and right frontal regions. No clinical or electrographic seizures were observed. The patient was subsequently started on Levetiracetam at 500 mg twice daily. After 3 months of therapy, he noted a significant decrease in the severity and frequency of his episodes.

Conclusion: Clinical differentiation between nocturnal seizures and parasomnias can be difficult. When a patient presents with unusual nocturnal behavior that is recurrent, stereotyped, or inappropriate, nocturnal seizures should be included in the differential diagnosis.

1107

RESOLUTION OF CENTRAL SLEEP APNEA DUE TO CHEYNE-STOKES RESPIRATION AFTER LEFT VENTRICULAR ASSIST DEVICE IMPLANTATION*Roberts S, Weir I*

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Introduction: Sleep-disordered breathing is common among patients with chronic heart failure. We describe a case of Central Sleep Apnea due to Cheyne-Stokes respiration which was eliminated following Left Ventricular Assist Device (LVAD) implantation.

Report of Case: Our patient is a 50-year-old female with a history of non-ischemic dilated cardiomyopathy with an ejection fraction of 10%, who complained of excessive daytime somnolence (EDS), loud snoring with witnessed apnea and frequent nocturnal awakening. Review of her medications showed no narcotic use. Her Epworth Sleepiness Scale (ESS) score was 12. A nocturnal polysomnogram (RemLogic S4500) was performed which showed an apnea-hypopnea index (AHI) of 60.7 events/hour, with an obstructive apnea index of 0.6 events/hour and central apnea index of 20.8 events/hour. Central sleep apnea due to Cheyne-Stokes respiration (CSA-CSR) was diagnosed. Supplemental oxygen and CPAP were ineffective. Adaptive servo-ventilation (ASV) study reduced the AHI to 0.9 events/hour. On follow up, she noted improvement in EDS and nocturnal awakening with ASV use. One year later she was admitted with biventricular failure despite diuretic use and was transferred to a tertiary medical center where a LVAD (Thoratec, HeartMate II) was implanted. Three months later she returned to the sleep center and was no longer using ASV. She denied EDS or insomnia symptoms. Her ESS score was 3. An out of center sleep study (Apnealink Plus) was performed per patient request seven months following LVAD implantation and showed an AHI of 2 events/hour with no central apnea.

Conclusion: We describe a case of complete resolution of CSA-CSR after LVAD implantation. Previous case reports have shown mixed effects on CSA-CSR with the use of cardiac mechanical assist devices and further study should be done in this patient population to better understand the effects of LVAD implantation on sleep-disordered breathing.

1108

SUPINE-RESTRICTED CENTRAL SLEEP APNEA ASSOCIATED WITH CHRONIC OPIATE USE*Sivaswami S¹, Drane K¹, McCarty DE¹, Liendo A³, Liendo C^{1,2}*

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Introduction: Patients with obstructive sleep apnea (OSA) often develop worsening airway obstruction in the supine sleeping position (SSP), whereas central sleep apnea (CSA) is not classically affected by position. Recently, cases of Cheyne-Stokes respiration were described to be position-sensitive. We present a case of CSA improved by left lateral decubitus sleeping position (LLDSP) in a patient taking chronic opiates.

Report of Case: A 57-year-old male with a history of chronic back pain experienced snoring and hypoxia during conscious sedation colonoscopy, and was subsequently referred for polysomnography (PSG). Past medical history was remarkable for prior head injury, noncritical coronary heart disease, with preserved ejection fraction. Head CT showed stable left frontal encephalo-malacia, with no evidence of Chiari's malformation. Body mass index was 30.6; Epworth score, 11. Oropharyngeal exam revealed a Mallampati class II-III airway. Medications included hydrocodone 10 mg every 6 hr and sustained release oxycodone, 20 mg thrice daily. Cardiopulmonary Type III PSG revealed an apnea hypopnea index of 31/hr, the majority of events being central apneas, with Biot's ataxic

breathing pattern noted. Oxyhemoglobin nadir was 86%. During adaptive servoventilation (ASV) titration, ASV effectively controlled events, but patient did not tolerate the intervention, and it was discontinued after one hour, and continued as a diagnostic study. CSA was subsequently noted to resolve in LLDSP, resuming once again in the SSP. The NREM-sleep LLDSC central-AHI was 0.5/hr, REM-sleep LLDSC Central-AHI was 0/hr, and NREM supine central-AHI was 84 events per hour.

Conclusion: Clinicians should be alerted to the fact that CSA and Biot's breathing pattern may exhibit a supine position dependence in patients taking chronic opiates.

1109

CAN BRAIN TUMORS OR THEIR RESECTION EXACERBATE RESTLESS LEG SYNDROME?: A NEW PERSPECTIVE*Raju P, Nimma A, Gupta D*

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Introduction: Restless legs syndrome (RLS) is a common cause of sleep disturbance (PREVALENCE -6%) in the middle aged population. This clinical syndrome is described as a movement-responsive, quiescent nocturnal focal akathisia usually with dysesthesias. RLS can be primary or secondary. Primary is idiopathic and is familial in up to 40% cases. Secondary causes include iron deficiency anemia, renal failure and pregnancy. RLS has been reported in association with central and peripheral nervous system pathology such as Parkinson's disease, multiple sclerosis, ALS, stroke, spinal stenosis, lumbosacral radiculopathy, acute spinal cord lesions and polyneuropathies. However, a literature search has not revealed prior reports of RLS in association with brain tumors.

Report of Case: We report 3 cases of RLS: 1 case appeared at the diagnosis of brain tumor, the other two got exacerbated after resection of brain tumors. Two of these cases did not have other factors causing RLS, and in one case RLS persisted after iron supplementation. Case1: A 32 year old female with rosette forming glioneural tumors in the tectal and pineal regions, and in bilateral thalami. Around the time of diagnosis of her tumor, she developed RLS symptoms that were "very severe" based on the IRLS rating scale. Case2: A 44 year old female with a history of right frontal lobe glioblastoma for which she underwent tumor resection. After tumor resection, she developed RLS symptoms which were "very severe" based on the IRLS rating scale. Case3: A 62 year old male with prolactinoma that was resected trans-sphenoidally. Post resection, he developed RLS symptoms that were "very severe" based on the IRLS scale.

Conclusion: We present cases of brain tumor that possibly have an association with RLS, and this is as yet unreported. Clinicians should be aware of the possible association, and be vigilant to look for and treat these symptoms in such patients.

1110

RESTLESS LEGS SYNDROME PRESENTING AS CHRONIC NOCTURNAL PELVIC PAIN*Newton KM, Tsai S*

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Introduction: Restless legs syndrome (RLS), or Willis-Ekbom disease, is a neurologic disorder that affects up to 15% of the population. 1) The symptoms are most typically present in the legs but can occur in the trunk or arms. (2) We discuss a case of restless legs syndrome presenting as chronic nocturnal pelvic pain.

Report of Case: A 40-year-old Caucasian male presented to our academic sleep medicine center with complaints of poor sleep for ten years. He noted chronic pelvic pain which was worse at night, disrupted his sleep, and was associated with initiation and maintenance insomnia. The

perineal pain started as an ache, increasing in intensity and discomfort, and ultimately resulting in deep pain. It occurred only when sedentary and was alleviated with movement and ambulation. His pertinent medical history included somnambulism, but he was otherwise healthy. Multiple neurologic and urologic evaluations were negative. Amitriptyline, nortriptyline, antibiotics, and narcotics had been tried as treatment. Nocturnal narcotics were successful in managing pain; however, he preferred non-narcotic therapy. Because his symptoms were consistent with a possible atypical presentation of restless legs syndrome, we elected to treat him with a dopamine agonist. He titrated the dose of ropinirole to 1 mg nightly with excellent success, with successful discontinuation of narcotics, and without recurrence of his pelvic symptoms.

Conclusion: Despite the unusual anatomic distribution of his discomfort, our patient's symptomatology was consistent with the diagnosis of RLS and responded well to RLS treatment. More patient data is needed to determine if chronic nocturnal pelvic pain/discomfort may be a variant of restless legs syndrome or Willis-Ekbom disease.

1111

SLEEP DISORDERS NOT TYPICALLY ASSOCIATED WITH DUCHENNE MUSCULAR DYSTROPHY: TWO CASE REPORTS

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Introduction: Duchenne Muscular Dystrophy (DMD) is an X-linked recessive disorder which results in progressive neuromuscular weakness over the first two decades of life. DMD is associated with obstructive sleep apnea and nocturnal hypoventilation that usually develop during the second decade of life. We report a case of narcolepsy and a case of restless leg disorder in two separate patients with DMD. After review of the literature available in PubMed, neither sleep disorder has been reported in DMD patients before.

Report of Cases: An 11-year-old male with DMD, wheelchair bound, presented to a pulmonologist for evaluation of restrictive lung disease. During the evaluation, the patient reported excessive daytime sleepiness while getting 10 hours of nocturnal sleep. Polysomnography (PSG) was performed with concern that the patient may have obstructive sleep apnea and a possible multiple sleep latency test (MSLT) was scheduled the following day to be performed if the AHI was less than 2. The PSG was negative for obstructive sleep apnea with an AHI of 1 and the end-tidal CO₂ levels were within normal limits. The MSLT revealed a mean sleep latency of 1.5 minutes and 3 SOREMs on 5 nap attempts. The patient was diagnosed with narcolepsy and started on methylphenidate 5 mg twice a day. His daytime sleepiness resolved and quality of life improved while on treatment. An 18-year-old male with DMD, wheelchair bound, presented to a routine pulmonology visit for concerns of worsening daytime fatigue. PSG was performed specifically for concerns of nocturnal hypoventilation. The AHI was 1.8 and end-tidal CO₂ levels were within normal limits. The periodic leg movement index was 20. The patient was re-evaluated and found to have symptoms consistent with restless leg syndrome. His ferritin level was 26, thus, he was started on iron supplementation. His daytime fatigue and RLS symptoms were improved at a six month follow-up visit.

Conclusion: We present a case of narcolepsy and a case of restless leg syndrome both of which have never been reported to be associated with DMD. When evaluating patients with DMD who report excessive daytime sleepiness or fatigue, other sleep disorders should be considered in the differential and not limited to either obstructive sleep apnea or nocturnal hypoventilation. Careful history with regards to narcolepsy and restless leg syndrome should be conducted in these patients. MSLT should be used more routinely in patients with excessive daytime sleepiness and DMD in the absence of obstructive sleep apnea and nocturnal hypoventilation.

1112

TRAMADOL: AN UNRECOGNIZED CAUSE OF CENTRAL SLEEP APNEA

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Introduction: Tramadol is considered a relatively safe option for treating moderate to severe chronic pain due to its low potential for abuse or dependence and its benign safety profile.

Report of Case: A 37-year-old woman was referred to a sleep clinician for excessive day time sleepiness and suspected obstructive sleep apnea. Her past medical history was significant for fibromyalgia, hypothyroidism, and obesity. Body mass index was 37. Medications included Levothyroxine, Duloxetine, and Tramadol. Initial polysomnogram revealed an apnea hypopnea index (AHI) of 56.4, with over 95% central apneas. It was hypothesized that these findings might be secondary to her Tramadol use, which ranged from 100-200 mg daily. Her polysomnogram was repeated two weeks later, after she had discontinued Tramadol. Her AHI had decreased to 14.9, again with over 95% being central apneas.

Conclusion: The most common adverse events of Tramadol are dizziness, drowsiness, vomiting and dry mouth. Sleep disorders are among some of the rarer side effects of Tramadol. Importantly, unlike other opioids, Tramadol has no clinically relevant effects on respiratory or cardiovascular parameters at recommended doses. Respiratory depression and apnea are can be associated with an overdose, but this patient was reportedly taking less than the maximum 300 mg daily. A postoperative study compared standard morphine patient-controlled analgesia and an opioid sparing protocol that included Tramadol. This study demonstrated that postoperative morphine dose predicted central apneas, however the postoperative dose of Tramadol was not predictive of respiratory events. This particular case would suggest however that Tramadol significantly worsened her central sleep apnea. Due to the increasing popularity and use of Tramadol, it is imperative that more studies be performed and that sleep clinicians are aware of this possible side effect.

1113

A SOBERING CURE FOR SEVERE CENTRAL SLEEP APNEA

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Introduction: Prescription opioid use has been on the rise for several years. The prevalence of sleep-disordered breathing has been reported to be as high as 75% in chronic opioid users. One previous case report was found in the literature of a patient with central sleep apnea that appeared to resolve on a subsequent overnight oximetry after discontinuing opiates.

Report of Case: A 44-year-old female with cerebral palsy and spinal stenosis was referred by her primary care physician (PCP) for a polysomnogram (PSG) in our sleep laboratory for excessive daytime sleepiness (Epworth 21/24). Medications included immediate-release and extended-release morphine. The study showed severe central sleep apnea with a central apnea index (CAI) of 54.5/hour, overall apnea-hypopnea index (AHI) of 58.5/hour, oxygen nadir of 91% and without evidence of sleep-related hypoventilation. A recommendation to wean morphine was made based on the severity of her sleep-disordered breathing. The patient was seen in our sleep medicine clinic approximately four months after her PSG and her PCP was able to completely wean her off morphine. A repeat PSG showed complete resolution of her sleep-disordered breathing with an AHI of 0.0/hour.

Conclusion: Although no universally accepted guidelines for the treatment of medication-induced central sleep apnea exist, this case demon-

strates that cessation of opioids should be a first-line treatment strategy in patients with central sleep apnea on chronic opioids.

1114

IDIOPATHIC HYPERSOMNIA: A CASE REPORT ON 3 FAMILY MEMBERS

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Introduction: Idiopathic hypersomnia (IH) is a disorder of severe excessive sleepiness despite adequate or prolonged sleep duration in the absence of a concurrent sleep disorder or other causes of somnolence. The disorder is distinct from narcolepsy and the pathogenesis is unclear. This is a report of 3 family members with IH.

Report of Cases: An 18-year-old female presented with excessive daytime sleepiness in the setting of nighttime sleep duration of 12 hours, difficulty awakening in the morning, and daily, un-refreshing naps lasting 1 to 2 hours. She had no symptoms suggestive of sleep disordered breathing or narcolepsy. An overnight polysomnogram (PSG) recorded 445 minutes of sleep and did not reveal obstructive sleep apnea. A multiple sleep latency test (MSLT) demonstrated sleep in 5 of 5 naps with a mean sleep latency of 3.3 minutes without sleep-onset REM periods. The patient's 19-year-old brother also complained of excessive daytime sleepiness despite 9 to 11 hours of uninterrupted sleep per night in the absence of symptoms of obstructive sleep apnea or narcolepsy. He took daily, 1 to 2 hour naps that were un-refreshing. An overnight PSG recorded 477 minutes of sleep and did not reveal obstructive sleep apnea. A MSLT recorded sleep in 5 of 5 naps with a mean sleep latency of 6.7 minutes without sleep onset REM periods. Family history revealed the patients' mother had a diagnosis of IH confirmed with MSLT. There is no history of IH in the patients' grandparents.

Conclusion: The cases of IH in this family may have a genetic component with an autosomal dominant mode of inheritance. This finding, in conjunction with another report of 3 cases spanning 2 generations and family members reporting unexplained excessive sleepiness in more than 30% of patients with IH suggest the possibility of a genetic contribution to this disorder.

1115

A CASE OF GORHAM'S DISEASE AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Gorham's disease is a rare bone disease of unknown etiology. First described by Gorham and associates in 1954, this disease is characterized by progressive and often severe osteolysis involving a single or multiple bones associated with proliferation of regional blood vessels. Gorham's disease does not have a known inheritance pattern or sex predilection.

Report of Case: A 61-year-old woman with a history of Gorham's disease was referred to the sleep disorders center for evaluation of excessive daytime sleepiness and snoring of one year duration. Her Epworth Sleepiness Scale score was 20/24. She had a history of both mandibular and cervical vertebral involvement. During the preceding two years she had undergone repair of bilateral iatrogenic mandibular fractures, one following the use of a dental night splint and the other following a routine root canal procedure. This was complicated by subsequent reabsorption of the majority of her left mandible. Diagnostic polysomnography revealed severe obstructive sleep apnea, with an Apnea Hypopnea Index (AHI) of 114 and oxygen saturation nadir of 77%. A subsequent titration study revealed persistent apnea associated with oxygen desaturations below 80% at the highest Bilevel Positive Airway Pressure

(BiPAP) setting tested (30/25 cm H₂O). The patient elected to undergo tracheotomy for definitive treatment of her obstructive sleep apnea. Her post-operative course was uneventful. The patient's post-operative Epworth Sleepiness Scale was 4/24.

Conclusion: Gorham's Disease is a rare bone reabsorption disorder of unknown etiology. When mandibular involvement is present there may be significant loss of anterior stabilization of the genioglossus muscle resulting in severe collapse of the retroglossal airway during sleep. This degree of collapse may be difficult or impossible to treat effectively even with the highest PAP settings available.

1116

PHARYNGEAL FLAP SURGERY AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Pharyngeal flap surgery is performed for treatment of velopharyngeal insufficiency which may present as either hypernasal speech or frank nasal reflux of liquids and food. Most commonly it is performed in children with a history of previous cleft palate repair but may also be performed in adults with similar symptoms. It involves creation of a superiorly based pharyngeal mucosal flap that is then sutured to the nasal surface of the central soft palate with lateral airway ports left open.

Report of Case: A 22-year-old male with presented with two-year history of excessive daytime sleepiness and snoring. His snoring first became noticeable shortly after completion of pharyngeal flap surgery for treatment of velopharyngeal insufficiency manifesting as hypernasal speech. His daytime sleepiness worsened over time leading to multiple episodes of inadvertently falling asleep at school. His Epworth Sleepiness Scale score at the time of his evaluation in the Sleep Disorders Clinic was 22/24. Physical examination revealed a BMI of 25 and neck circumference of 15.5 inches. Nasal examination was normal. Intraoral examination revealed no evidence of macroglossia, 1+ tonsils, Mallampati II class and a well healed pharyngeal flap at the midline velopharyngeal area. Initial diagnostic polysomnography revealed an AHI an RDI of 3.7 with an oxygen saturation nadir of 91%. Poor nasal flow signal was noted which may have led to an underestimation of disease severity. Repeat testing with use of pressure esophageal monitoring revealed an AHI of 5.3, an RDI of 9 and an oxygen saturation nadir of 90% consistent with a diagnosis of mild OSA and upper airway resistance syndrome. A CPAP titration study was recommended.

Conclusion: Pharyngeal flap surgery invariably leads to some degree of velopharyngeal narrowing. This narrowing typically improves symptoms of velopharyngeal insufficiency but may lead to increased upper airway resistance and obstructive sleep apnea.

1117

APPEARANCE OF CENTRAL APNEA AFTER SURGICAL DECOMPRESSION OF CHIARI MALFORMATION

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Introduction: Chiari I malformation is characterized by an extension of the cerebellar tonsils by ≥ 5 mm through the foramen magnum, causing restriction of CSF flow. It has been associated with both obstructive and central sleep apnea, likely due to the close proximity of the respiratory centers to the foramen magnum. Case reports and series have shown improvement in central sleep apnea following posterior fossa decompression; however, a large case series demonstrated that 22% experienced mild to moderate symptom recurrence while 7% required revision decompression. It has been suggested that reemergence of apneas may be a patient's sole presenting sign of recurrent brainstem compression necessitating further intervention.

Report of Case: We present a 5-year-old female with history of complex partial epilepsy, adenotonsillectomy, headaches, and an incidental MRI finding of a Chiari I malformation (cerebellar tonsils extended 20 mm beyond the foramen magnum with evidence of CSF flow restriction) and a T5-T10 syrinx. Because of significant headaches, the patient underwent surgical decompression without intraoperative complications. Postoperatively, her headaches persisted and parents distinctly reported new onset apneas prompting polysomnography testing. It showed a central apnea index of 25.7 per hour of sleep and oxygen desaturations into the 70 s requiring 1 LPM of supplemental oxygen. Consequently, repeat imaging was performed, showing improvement in tonsillar extension, but persistence of CSF flow restriction. Repeat surgical decompression was performed. She awaits post-decompression polysomnography.

Conclusion: This case of central sleep apnea and Chiari malformation is unique in that the report of apnea developed after surgical decompression, as opposed to before. The malformation may have been only partially corrected by the first decompression; thus the second was needed. The case highlights the importance of apnea as a sign of recurrent brainstem compression and supports use of polysomnography post-decompression to direct timely intervention.

1118

IT'S ALL IN YOUR HEAD

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Introduction: Sleep disordered breathing (SDB) is a significant health concern in children. The first-line treatment for clinically significant pediatric obstructive sleep apnea (OSA), is adenotonsillectomy (AT). However, in cases where AT fails to cure OSA, investigation of other potential etiologies of SDB is warranted.

Report of Case: A non-obese, non-syndromic, Caucasian 7-year-old male with snoring presented to a community otolaryngologist with a history of severe OSA (apnea hypopnea index, AHI = 26 events/hour) on polysomnography (PSG). A repeat PSG, 3 months after AT, demonstrated persistent severe OSA. The patient was then referred to our institution and reviewed in our combined sleep medicine and otolaryngology clinic. An awake, flexible nasopharyngoscopy was normal. A CPAP titration PSG and a diagnostic MRI brain were ordered. The titration study demonstrated control of the OSA with a CPAP pressure of 9 cm H₂O but significant central sleep apnea (CSA) was evident at all CPAP pressures. The overall central apnea index was 14.4 events/hour. The MRI brain demonstrated a Chiari I malformation with significant crowding of neural structures at the craniocervical junction and cerebellar tonsillar descent to the level of C2. Urgent surgical decompression was performed. A repeat PSG 2 months later demonstrated mild OSA (AHI = 2 events/hour) and resolution of the CSA.

Conclusion: Children with persistent severe OSA despite AT, particularly in the absence of risk factors (obesity, craniofacial syndromes or hypotonia/neuromuscular disease), are atypical and warrant further diagnostic testing. The sleep physician and pediatrician should be aware that central nervous system pathologies such as Chiari malformation and tumours may present with OSA or CSA in isolation or as mixed apnea. Our case highlights the importance of diagnostics for persistent SDB and reinforces that pediatric sleep apnea is not just tonsils and adenoids.

1119

86 DAY OLD BABY WITH TRISOMY 21, ESOPHAGEAL ATRESIA WITH TRACHEOESOPHAGEAL FISTULA AND SEVERE OBSTRUCTIVE SLEEP APNEA: A CASE REPORT

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Introduction: Infants born with congenital abnormalities of the upper airway have significantly high risk for obstructive sleep apnea due to their anatomical and physiological predisposition towards airway collapse. This puts them at increased risk for failure to thrive, neurocognitive deficits and sudden infant death. Early diagnosis and management may have a significant role in minimizing the long-term complications. Treatment options in infants are often surgical and based on the underlying etiology.

Report of Case: 86-day-old baby with Trisomy 21, esophageal atresia with tracheoesophageal fistula and patent ductus arteriosus was referred for evaluation of obstructive sleep apnea (OSA). Baby was born at 39 weeks of gestation by vaginal delivery, and had tracheoesophageal fistula repair on the first day of life. She had a soft cry, persistent stridor, and reported choking at night. Weight gain since birth was suboptimal at 15-20 grams per day. Physical exam was significant for Down's facies with mid-face hypoplasia, bilateral epicanthal folds, and glossoptosis. Overnight polysomnography (PSG) showed severe obstructive sleep apnea with an apnea-hypopnea index of 17 (46 in REM), stridor and paradoxical breathing. Minimum oxygen saturation was 89%. End tidal CO₂ was normal. Therapeutic trial of supplemental oxygen via nasal cannula didn't have significant benefit. Airway evaluation revealed moderate laryngomalacia and left vocal cord dysfunction. She is scheduled to undergo supraglottoplasty with follow up PSG 1 month after surgery.

Conclusion: Infants with moderate to severe OSA and failure to thrive must receive aggressive treatment. Studies have shown poor tolerance to CPAP by infants. Adenotonsillectomy is effective in older children with adenotonsillar hypertrophy. Surgical management of laryngomalacia with supraglottoplasty is favored in infants with OSA. Other treatment modalities include lip-tongue adhesion, mandibular distraction osteogenesis, placement of nasopharyngeal tube and tracheostomy. This case demonstrates the need for aggressive evaluation, treatment, and follow-up of patients at risk for airway obstruction.

1120

NOCTURNAL HEADACHES, IDIOPATHIC INTRACRANIAL HYPERTENSION, AND RETINAL VEIN OCCLUSIONS AS PRESENTING SIGNS OF OBSTRUCTIVE SLEEP APNEA

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Introduction: Among ophthalmologic diseases, glaucoma, and papilledema have been suggested to be associated with obstructive sleep apnea (OSA). It has also been observed that patients with retinal vein occlusion (RVO) exhibit symptoms of visual loss on awakening, alluding to the possibility of nocturnal events contributing to its pathogenesis. We report a case of nocturnal headaches, idiopathic intracranial hypertension (IIH), and multiple episodes of RVO as presenting symptoms of OSA.

Report of Case: A 57-year-old woman with a history of two left eye RVO with subsequent total loss of vision to the left eye and a right eye RVO presented with complaints of nightly headaches awakening her from sleep since the initial RVO. She described a holoccephalic headache with

bilateral retro-orbital pulsations that awakened her multiple times each night. Magnetic resonance imaging, angiogram and venogram of the brain, cardiovascular work up and hypercoagulable tests were negative. She was found to have idiopathic intracranial hypertension (IIH) and treatment resistant arterial hypertension requiring multiple medications for adequate control. However, her nocturnal headaches persisted along with daytime sleepiness, snoring, and witnessed apneas. Physical exam revealed a crowded oropharynx, large tongue, and a high arched palate. Split night polysomnography showed an apnea-hypopnea index of 56.9 and a lowest oxygen desaturation of 75%. Therapeutic continuous positive airway pressure (CPAP) was 8 cm H₂O. On follow up evaluation, she demonstrated optimal compliance with CPAP and complete resolution of her nocturnal headaches, retro-orbital pulsatile pain and daytime sleepiness. Subsequently, the patient went without CPAP for 3 nights, while traveling, with recurrence of nocturnal headaches and pulsatile sensations that resolved after resuming CPAP.

Conclusion: Retinal vein occlusion should raise the suspicion for obstructive sleep apnea especially if associated with nocturnal headaches and daytime sleepiness.

1121

A 54 YEAR OLD MAN WITH ACUTE ONSET ORTHOPNEA AND SLEEP-RELATED HYPOXIA

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Introduction: Bilateral isolated phrenic neuropathy (BIPN) presents as a painless paralysis of the diaphragm with a relatively acute onset, and without antecedent factors such as infection or prior surgery. Diaphragmatic weakness in BIPN is most often persistent, requiring lifelong non-invasive ventilatory support.

Report of Case: 54-year-old white man presented with a 6 month history of supine positional snoring and progressive orthopnea. Denied any witnessed apneas or snort arousals. He slept in a recliner. ESS was 5. Chest examination demonstrated limited diaphragmatic excursions. Upon recumbency, he became tachypneic and had abdominal paradox with accessory muscle activation. On 2L oxygen therapy, overnight oximetry demonstrated sustained hypoxemia below 88% saturation. His daytime ABG on 2L oxygen showed pH-7.36, Pco₂-59, Po₂-68 with an A-a gradient of 58 mmHg. Spirometry showed restrictive pattern with mildly decreased DLCO. Diaphragmatic fluoroscopy confirmed bilateral diaphragmatic dysfunction and elevation. CT chest was negative for parenchymal changes. EMG showed absent bilateral phrenic nerve conductions and right hemidiaphragmatic fibrillation potentials. Brachial plexus MRI was negative. Polysomnographic titration of bi-level PAP in timed mode with inspiratory/expiratory pressures of 14/7 cm at 12 breaths per minute with blended oxygen at 2.5 liters per minute normalized oxyhemoglobin saturation.

Conclusion: The prominent orthopnea and abdominal paradoxical breathing were highly suggestive signs of bilateral diaphragmatic weakness. The differentials included BIPN and neuralgic amyotrophy (NA, aka Parsonage-Turner Syndrome). NA is a distinct, painful brachial plexus neuropathy causing patchy, multifocal paresis and sensory loss in one or both arms, with rare involvement of the phrenic nerves. Our patient was diagnosed with BIPN due to painless onset, subacutely evolving symmetrical diaphragmatic weakness, and absence of upper limb symptoms or electromyographic denervation. Our patient has done well on bi-level PAP therapy with blended oxygen. However, successful relief of orthopnea and dyspnea symptoms in BIPN patients by surgical diaphragmatic plication has been reported.

1122

NARCOLEPSY AND INFLUENZA VACCINATION: A CASE OF NARCOLEPSY DIAGNOSIS FOLLOWING ADMINISTRATION OF AN ADJUVANTED H5N1 INFLUENZA VACCINE

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Introduction: We describe a case of narcolepsy occurring after receiving an adjuvanted H5N1 avian influenza vaccine.

Report of Case: A 31-year-old physician presented with progressive daytime sleepiness 2-3 months after receiving an adjuvanted H5N1 influenza vaccine in a clinical trial. When his sleepiness began, he had episodes of syncope and falls without loss of consciousness, one resulting in a wrist fracture. Cardiac evaluation revealed asymptomatic bradycardia and high vagal tone. Despite trials of methylxanthine therapy, his symptoms progressed. Over the following year, his weight increased 21 kg but was subsequently improved with intensive exercise. He reported variable sleep latency and 8-9 hours of total sleep time. He had frequent sleep attacks that resolved with napping, nightly hypnagogic hallucinations, and episodes of sleep paralysis. His wife denied snoring, apneas, or abnormal movements. Exam revealed a heart rate of 50, normal oxygen saturation, body mass index of 23 kg/m², and a class 1 Mallampati score. His initial Epworth sleepiness scale score was 21. Overnight polysomnogram showed a sleep latency of 10.5 minutes, 92% sleep efficiency, REM latency of 145 minutes with 4 discrete REM periods, with no evidence of sleep disordered breathing or movement disorder. Multiple sleep latency testing revealed a mean sleep latency of 8 minutes with 2 sleep-onset REM periods. He was diagnosed with narcolepsy, and modafinil was initiated. After 12 weeks of therapy, daytime sleepiness was improved; however, the patient had worsening hypnagogic hallucinations, sleep paralysis, and cataplexy without syncope. Sodium oxybate was added to modafinil.

Conclusion: Beginning in 2010, there has been an increased incidence of narcolepsy in patients receiving an adjuvanted H1N1 influenza vaccine. In November 2013, the FDA approved the first adjuvanted influenza vaccine (H5N1) for use in the United States. This is the first reported case of narcolepsy following administration of an adjuvanted H5N1 influenza vaccine.

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NARCOLEPSY IN A YOUNG BOY FOLLOWING LYME DISEASE

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Introduction: Narcolepsy is a neurological disorder characterized by depletion of the hypocretin secreting neurons in the hypothalamus. It is believed to be an autoimmune process, often triggered by an infectious or environmental agent in a genetically susceptible individual. Lyme disease as a potential trigger has not been described.

Report of Case: An eight-year-old boy presented with excessive daytime sleepiness (EDS), weight gain and mood changes for 4 months, as well as features of cataplexy on laughing ("becoming like a noodle"). He was sleeping over 12 hours nightly with frequent daytime naps (total sleep 15-16 hours). The modified Epworth Sleepiness Scale score (mESS) was 18/24. BMI was above the 90th percentile, examination was otherwise unremarkable. Two months prior to the presentation he was diagnosed with Lyme disease, based on positive antibody ELISA titers,

IgG and IgM by western blot and received amoxicillin and doxycycline. The parents denied tick bite, or rash, but live in an endemic area. Clinical presentation was consistent with narcolepsy with cataplexy. Laboratory evaluation revealed, positive ASO titers, improving Lyme titers, and decreasing Lyme IgM. HLA testing was positive for DQB1*06:02 and DRB1*15:02. Thyroid and monospot testing, as well as brain MRI were normal. Polysomnogram revealed a total sleep duration of 560.5 min, reduced sleep latency (5.7 min), and increased REM sleep (41.4%), with fragmented macro-sleep architecture. MSLT confirmed narcolepsy (reduced mean sleep latency – 1.1 min, sleep onset REM periods in 5/5 naps and a mean REM latency of 2 min). He was treated with methylphenidate and venlafaxine. On follow up he is doing well, his excessive sleepiness has resolved (mESS 5/24) and cataplexy has significantly reduced.

Conclusion: Lyme disease may have acted as a trigger of narcolepsy in this patient. Narcolepsy should be considered in the differential diagnosis of EDS in children after Lyme disease.

1124

SKULL DEFORMITY: UNDESIRE COMPLICATION OF CPAP USE IN CHILDREN

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Introduction: Obstructive sleep apnea (OSA) is present in 2-3% of children. First-line therapy is adenotonsillectomy; however, up to 20-40% of children may have incomplete resolution of OSA after surgery. In this population, continuous positive airway pressure (CPAP) therapy is often indicated. Previous studies have reported midfacial hypoplasia in children using nasal CPAP. We describe a unique craniofacial development from the CPAP headgear as opposed to mask.

Report of Case: A 4-year-old Anglo-Asian boy initially began snoring as an infant. At 3 years of age, he underwent adenotonsillectomy, but snoring persisted. A post-operative polysomnogram revealed moderate OSA. He was treated with fluticasone nasal spray, revision adenoidectomy and inferior nasal turbinate reduction. Repeat polysomnography revealed an apnea hypopnea index of 17 per hour of sleep. Consequently, he was started on CPAP at 4.8 cm of water after undergoing titration. The patient tolerated a pediatric nasal cushion mask. The mask specific headgear extended horizontally over the cheeks, split superiorly and inferiorly anterior to the ear. Inferiorly, it wrapped below the occiput. Superiorly, it extended towards the parietal bone and split into a band overlying the vertex and a band wrapping around the posterior parietal region. Two compliance downloads over the last 9 months showed average daily use ranging from 6.2 hours to 9 hours per night, and usage > 4 hours ranging from 73.3% to 85%. The patient was seen in clinic at ~ 4.5 month intervals. One year after initiating CPAP, physical examination revealed indentations along the parietal bones that corresponded to where the superior component of the headgear rested. However, he had not developed abnormal maxillary hypoplasia.

Conclusion: This case illustrates another potential cranial change that can be seen with pediatric CPAP use. It underscores the importance of regular follow-up with pediatric CPAP patients, perhaps at more frequent intervals, to check mask and headgear fit.

1125

ADENOTONSILLECTOMY: NOT A “HAPPILY EVER AFTER” STORY

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Introduction: 1-3% of children ages 2-8 years of age have obstructive sleep apnea due to adenotonsillar hypertrophy. Adenotonsillectomy has

been the treatment of choice with an approximate 80% cure rate. What happened to the 20%?

Report of Case: A 5 year old female presented at age 3 due to residual symptoms of obstructive sleep apnea following an adenotonsillectomy at 2 years of age. She had a straight nasal septum and normal-sized inferior turbinates without nasal discharge. A diagnostic polysomnogram revealed severe pediatric obstructive sleep apnea with an obstructive respiratory index of 12/hour of sleep (abnormal > 1.5). ENT saw and diagnosed her with nasopharyngeal stenosis. A modified pharyngeal flap was performed followed by divisions of nasal cavity synechiae and Kenalog injections. During the procedure, gastric contents was seen in the nasopharynx concerning for gastroesophageal reflux. She subsequently underwent a Nissen fundoplication for gastroesophageal reflux disease and since then, has been sleeping well without waking up choking, vomiting and gasping for air. She continues to snore. A polysomnogram demonstrated persistence of severe pediatric obstructive sleep apnea. Therefore, mask desensitization was initiated and she was successfully titrated with an Auto-PAP of 4-10 cwp. She exhibits good adherence to treatment.

Conclusion: Nasopharyngeal stenosis from an adenotonsillectomy is a rare but serious complication. The etiology is due to devascularization with excessive mucosal destruction and/or keloid diathesis. Symptoms of nasal obstruction, mouth breathing, rhinosinusitis and obstructive sleep apnea occurring within 10 weeks of surgery should prompt immediate attention. Treatment is challenging because of its high recurrence rate even after surgical repair.

1126

RESISTANT UNILATERAL RESTLESS LEG SYNDROME ASSOCIATED WITH UNTREATED SLEEP APNEA

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Introduction: Medical literature supports that obstructive sleep apnea can precipitate restless leg syndrome (RLS). Also, RLS may improve with effective treatment of coexisting sleep apnea (OSA). Restless leg syndrome typically involves both legs. This is a case of resistant unilateral RLS symptoms associated with unrecognized OSA.

Report of Case: A 33-year-old male reported poor sleep due to the urgent sensation to move his right leg progressively worsening over 5-10 years. The urge was classic with symptoms primarily at night, worsened with immobility, improved with activity. Good sleep habits and hygiene were documented. Patient reported snoring and morning dry mouth, no witnessed apneas and daytime fatigue but no sleep attacks. Marginal benefits with Pramipexole lead to addition of Zolpidem with some improvement in sleep complaints. Mild depression was effectively treated with citalopram. No negative impact on RLS due to the drug addition was noted. His father had similar unilateral leg symptoms through his adult life. Exam was notable for crowded airway, mild retrognathia and BMI of 32. Neurologic and musculoskeletal systems were normal. Prior work up included a normal ferritin, TSH, Vitamin B12, creatinine, glucose, CBC and electromyography-nerve conduction study. We completed a sleep study with severe sleep apnea present an AHI (apnea hypopnea index) of 28 consistent with moderate sleep apnea. CPAP initiated resolved the persistent RLS symptoms.

Conclusion: Unilateral RLS is rare. OSA is not. Atypical presentations for sleep disorders especially when poorly responsive to therapy should alert the physicians to search for alternative diagnoses.

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