Practice Parameters for the Use of Autotitrating Continuous Positive Airway Pressure Devices for Titrating Pressures and Treating Adult Patients with Obstructive Sleep Apnea Syndrome: An Update for 2007

An American Academy of Sleep Medicine Report

Timothy I. Morgenthaler, MD; R. Nisha Aurora, MD; Terry Brown, DO; Rochelle Zak, MD; Cathy Alessi, MD; Brian Boehlecke, MD; Andrew L. Chesson Jr, MD; Leah Friedman, MA, PhD; Vishesh Kapur, MD, MPH; Rama Maganti, MD; Judith Owens, MD; Jeffrey Pancer, DDS; Todd J. Swick, MD; Standards of Practice Committee of the AASM

1. INTRODUCTION

Continuous positive airway pressure (CPAP) is a standard, safe, and efficacious treatment for the obstructive sleep apnea syndrome (OSA). CPAP allows for interventions to adjust mask fit, eliminate leak, and allow for direct observation by trained technologists to guide hypopneas in all sleep stages and body positions. In addition to helping the patient adapt to the initial CPAP experience, CPAP results in improvements of the quality of life and adverse consequences for cardiovascular health.

Disclosure Statement
This is not an industry supported study. The authors have indicated no financial conflicts of interest.

Submitted for publication November, 2007
Accepted for publication November, 2007
Address correspondence to: Standards of Practice Committee, American Academy of Sleep Medicine, One Westbrook Corporate Center, Suite 920, Westchester IL 60154, Phone: (708) 492-0930, Fax: (708) 492-0943, Email: aasm@aasmnet.org

SLEEP, Vol. 31, No. 1, 2008

Practice Parameter for APAP—Morgenthaler et al

PRACTICE PARAMETER FOR AUTO-CPAP

These practice parameters are an update of the previously published recommendations regarding the use of autotitrating positive airway pressure (APAP) devices for titrating pressures and treating adult patients with obstructive sleep apnea syndrome. Continuous positive airway pressure (CPAP) at an effective setting verified by attended polysomnography is a standard treatment for obstructive sleep apnea (OSA). APAP devices change the treatment pressure based on feedback from various patient measures such as airflow, pressure fluctuations, or measures of airway resistance. These devices may aid in the pressure titration process, address possible changes in pressure requirements throughout a given night and from night to night, aid in treatment of OSA when attended CPAP titration has not or cannot be accomplished, or improve patient comfort. A task force of the Standards of Practice Committee of the American Academy of Sleep Medicine has reviewed the literature published since the 2002 practice parameter on the use of APAP. Current recommendations follow: (1) APAP devices are not recommended to diagnose OSA; (2) patients with congestive heart failure, patients with significant lung disease such as chronic obstructive pulmonary disease; patients expected to have nocturnal arterial oxyhemoglobin desaturation due to conditions other than OSA (e.g., obesity hypoventilation syndrome); patients who do not snore (either naturally or as a result of palate surgery); and patients who have central sleep apnea syndromes are not currently candidates for APAP titration or treatment; (3) APAP devices are not currently recommended for split-night titration; (4) certain APAP devices may be used during attended titration with polysomnography to identify a single pressure for use with standard CPAP for treatment of moderate to severe OSA; (5) certain APAP devices may be initiated and used in the self-adjusting mode for unattended treatment of patients with moderate to severe OSA without significant comorbidities (CHF, COPD, central sleep apnea syndromes, or hypoventilation syndromes); (6) certain APAP devices may be used in an unattended way to determine a fixed CPAP treatment pressure for patients with moderate to severe OSA without significant comorbidities (CHF, COPD, central sleep apnea syndromes, or hypoventilation syndromes); (7) patients being treated with fixed CPAP on the basis of APAP titration or being treated with APAP must have close clinical follow-up to determine treatment effectiveness and safety; and (8) a re-evaluation and, if necessary, a standard attended CPAP titration should be performed if symptoms do not resolve or the APAP treatment otherwise appears to lack efficacy.

Keywords: Obstructive sleep apnea; continuous positive airway pressure; CPAP; sleep disordered breathing; autotitrating; APAP

Citation: Morgenthaler TI; Aurora RN; Brown T; Zak R; Alessi C; Boehlecke B; Chesson AL; Friedman L; Kapur V; Maganti R; Owens J; Pancer J; Swick TJ; Standards of Practice Committee of the AASM. Practice parameters for the use of autotitrating continuous positive airway pressure devices for titrating pressures and treating adult patients with obstructive sleep apnea syndrome: An update for 2007. SLEEP 2008;31(1):141-147.

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) IS A STANDARD, SAFE, AND EFFICACIOUS TREATMENT FOR THE OBSTRUCTIVE SLEEP APNEA SYNDROME (OSA), a common disorder with established detriment to quality of life and adverse consequences for cardiovascular health. Most of the published literature supporting CPAP therapy derives from trials where the treatment pressure is established by direct inspection of sleep and breathing parameters during attended polysomnographic recording while adjusting pressures to find a setting that essentially eliminates apneas and hypopneas in all sleep stages and body positions. In addition to allowing direct observation by trained technologists to guide pressure selection, titration under attended polysomnography allows for interventions to adjust mask fit, eliminate leak, and help the patient adapt to the initial CPAP experience.

However, as noted in the previous review and practice parameters paper, there are some assumed or potential limitations associated with PSG-directed CPAP determinations. These include the cost and inconvenience of repeat PSG due to in-
The Standards of Practice Committee (SPC) of the AASM commissioned among its members four individuals with expertise in the use of APAP to conduct this review. These content experts were appointed in June, 2006 to review and grade evidence in the peer-reviewed scientific literature regarding the use of APAP. A search for articles on treatment of obstructive sleep apnea with autotitrating CPAP (APAP) was conducted using EMBASE, Ovid MEDLINE(R), Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, and the Cochrane Clinical Trial Registry, first on August 25, 2006, and updated on November 7, 2006. Key words for searches included autoCPAP, automatic CPAP, autotitrating CPAP, autoset, auto PAP, and autoadjusting CPAP. Each search was run separately and findings were merged. When the search was limited to articles published in English and regarding humans, a total of 167 articles were identified. Abstracts from these articles were reviewed to determine if they met inclusion criteria. Articles were included for evaluation if they had more than 9 subjects and if they compared APAP use with standard PSG directed CPAP therapy, a standard alternate therapy (oral appliance, surgery), or another APAP device. The articles had to address at least one of eight “PICO” questions (acronym standing for Patient, Population or Problem, provided a specific Intervention or exposure, after which a defined Comparison is performed on specified Outcomes) that were decided upon ahead of the review process. While the PICO questions do not map one-to-one with the practice parameters, they were designed to generate information that would be useful in updating the existing practice parameters. Articles meeting these criteria in addition to those identified by pearl- ing (i.e., checking the reference sections of search results for articles otherwise missed) provided 22 articles for review and grading (see accompanying evidence table).

The grading of evidence was according to the suggestions of Sackett (Table 1). All evidence grading was performed by independent review of the article by two members of the task force. Areas of disagreement were addressed by the task force until resolved. The strength of recommendations was determined by the entire AASM SPC as standards, guidelines, or options, as defined in Table 2. Overall, there were 8 Level I studies, 10 Level II studies, 1 Level III study, and 1 Level IV study. One study had bearing on the review but was not graded, as it did not directly address any of the PICO questions (See Table 3).

### Table 1—AASM Classification of Evidence

<table>
<thead>
<tr>
<th>Evidence Levels</th>
<th>Study Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Randomized, well-designed trials with low alpha and beta error*</td>
</tr>
<tr>
<td>II</td>
<td>Randomized trials with high alpha and beta error*</td>
</tr>
<tr>
<td>III</td>
<td>Nonrandomized concurrently controlled studies</td>
</tr>
<tr>
<td>IV</td>
<td>Nonrandomized historically controlled studies</td>
</tr>
<tr>
<td>V</td>
<td>Case series</td>
</tr>
</tbody>
</table>

*Alpha (type I error) refers to the probability that the null hypothesis is rejected when in fact it is true (generally acceptable at 5% or less, or P <0.05). Beta (type II error) refers to the probability that the null hypothesis is mistakenly accepted when in fact it is false (generally trials accept a beta error of 0.20). The estimation of type II error is generally the result of a power analysis. The power analysis takes into account the variability and the effect size to determine if sample size is adequate to find a difference in means when it is present (power generally acceptable at 80%-90%).

### Table 2—AASM Levels of Recommendations

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>This is a generally accepted patient care strategy that reflects a high degree of clinical certainty. The term standard generally implies the use of Level I evidence, which directly addresses the clinical issue, or overwhelming Level II evidence.</td>
</tr>
<tr>
<td>Guideline</td>
<td>This is a patient care strategy that reflects a moderate degree of clinical certainty. The term guideline implies the use of Level II evidence or a consensus of Level III evidence.</td>
</tr>
<tr>
<td>Option</td>
<td>This is a patient care strategy that reflects uncertain clinical use. The term option implies inconclusive or conflicting evidence or conflicting expert opinion.</td>
</tr>
</tbody>
</table>

Adapted from Eddy12

The purpose of this practice parameter paper is to present updated recommendations for using APAP to determine the need for or to provide treatment for OSA. The American Academy of Sleep Medicine (AASM) has previously published practice parameters for CPAP and bilevel positive airway pressure (BPAP) therapy, and the recommendations here do not modify those guidelines.3 The AASM also has previously published practice parameters on the determination of CPAP pressure for the treatment of OSA.3 The recommendations here supplement those previous guidelines for using APAP to titrate CPAP or treat OSA.

### 2. METHODS

The Standards of Practice Committee (SPC) of the AASM commissioned among its members four individuals with expertise in the use of APAP to conduct this review. These content experts were appointed in June, 2006 to review and grade evidence in the peer-reviewed scientific literature regarding the use of APAP. A search for articles on treatment of obstructive sleep apnea with autotitrating CPAP (APAP) was conducted using EMBASE, Ovid MEDLINE(R), Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, and the Cochrane Clinical Trial Registry, first on August 25, 2006, and updated on November 7, 2006. Key words for searches included autoCPAP, automatic CPAP, autotitrating CPAP, autoset, auto PAP, and autoadjusting CPAP. Each search was run separately and findings were merged. When the search was limited to articles published in English and regarding humans, a total of 167 articles were identified. Abstracts from these articles were reviewed to determine if they met inclusion criteria. Articles were included for evaluation if they had more than 9 subjects and if they compared APAP use with standard PSG directed CPAP therapy, a standard alternate therapy (oral appliance, surgery), or another APAP device. The articles had to address at least one of eight “PICO” questions (acronym standing for Patient, Population or Problem, provided a specific Intervention or exposure, after which a defined Comparison is performed on specified Outcomes) that were decided upon ahead of the review process. While the PICO questions do not map one-to-one with the practice parameters, they were designed to generate information that would be useful in updating the existing practice parameters. Articles meeting these criteria in addition to those identified by pearling (i.e., checking the reference sections of search results for articles otherwise missed) provided 22 articles for review and grading (see accompanying evidence table).

The grading of evidence was according to the suggestions of Sackett (Table 1). All evidence grading was performed by independent review of the article by two members of the task force. Areas of disagreement were addressed by the task force until resolved. The strength of recommendations was determined by the entire AASM SPC as standards, guidelines, or options, as defined in Table 2. Overall, there were 8 Level I studies, 10 Level II studies, 1 Level III study, and 1 Level IV study. One study had bearing on the review but was not graded, as it did not directly address any of the PICO questions (See Table 3).

### Table 1—AASM Classification of Evidence

<table>
<thead>
<tr>
<th>Evidence Levels</th>
<th>Study Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Randomized, well-designed trials with low alpha and beta error*</td>
</tr>
<tr>
<td>II</td>
<td>Randomized trials with high alpha and beta error*</td>
</tr>
<tr>
<td>III</td>
<td>Nonrandomized concurrently controlled studies</td>
</tr>
<tr>
<td>IV</td>
<td>Nonrandomized historically controlled studies</td>
</tr>
<tr>
<td>V</td>
<td>Case series</td>
</tr>
</tbody>
</table>

*Alpha (type I error) refers to the probability that the null hypothesis is rejected when in fact it is true (generally acceptable at 5% or less, or P <0.05). Beta (type II error) refers to the probability that the null hypothesis is mistakenly accepted when in fact it is false (generally trials accept a beta error of 0.20). The estimation of type II error is generally the result of a power analysis. The power analysis takes into account the variability and the effect size to determine if sample size is adequate to find a difference in means when it is present (power generally acceptable at 80%-90%).
The Board of Directors of the AASM approved these recommendations. All members of the AASM Standards of Practice Committee and Board of Directors completed detailed conflict-of-interest statements and were found to have no conflicts of interest with regard to this subject.

These practice parameters define principles of practice that should meet the needs of most patients in most situations. These guidelines should not, however, be considered inclusive of all proper methods of care or exclusive of other methods of care reasonably directed to obtaining the same results. The ultimate judgment regarding propriety of any specific care must be made by the physician in light of the individual circumstances presented by the patient, available diagnostic tools, accessible treatment options, and resources.

The AASM expects these guidelines to have an impact on professional behavior, patient outcomes, and, possibly, health care costs. These practice parameters reflect the state of knowledge at the time of publication and will be reviewed, updated, and revised as new information becomes available.

3. RECOMMENDATIONS

3.1. APAP is not recommended to diagnose OSA. (Standard)

Treatment for OSA must be based on a prior diagnosis of OSA by an established method. APAP devices are not intended for diagnostic purposes. This recommendation, although reworded, is unchanged from the previous parameter paper. We found no new evidence addressing the use of autotitrating devices for the diagnosis of OSA.

3.2. Patients with congestive heart failure, significant lung disease such as chronic obstructive pulmonary disease, patients expected to have nocturnal arterial oxyhemoglobin desaturation due to conditions other than OSA (e.g., obesity hypoventilation syndrome), patients who do not snore (either naturally or as a result of palate surgery), and patients who have central sleep apnea syndromes are not currently candidates for APAP titration or treatment. (Standard)

This recommendation is unchanged from the previous parameter paper. Most studies evaluating APAP, regardless of the technology used, exclude such patients because the sensors and algorithms identifying respiratory events may not be sensitive or specific under these circumstances.

3.3. APAP devices are not currently recommended for split-night titration. (Standard)

This recommendation is unchanged from the previous parameter paper. None of the reviewed studies examined APAP under conditions of an initial diagnostic period followed by a titration period in the same overnight study.

3.4. Certain APAP devices may be used during attended titration with polysomnography to identify a single pressure for use with standard CPAP for treatment of moderate to severe OSA. (Guideline)

This recommendation is unchanged from the previous parameter paper, except that the severity of OSA is now specified. One potential use of APAP is to identify a single pressure
for use with a standard CPAP device for subsequent treatment of OSA. The prior recommendation had been based on Level I and II evidence. Based upon that review, APAP devices using methods that monitor snoring, apnea or hypopnea by airflow, flow contour, and/or impedance by the forced oscillation technique may effectively determine a pressure to reduce sleep disordered breathing events to the same extent as standard CPAP. The updated review did not reveal new evidence directly comparing APAP titrations against technologist-directed PAP titrations over a single night. However, four studies (1 Level I, 1 Level II, 1 Level III, 1 not graded) evaluated different aspects of APAP effectiveness using polysomnography. One Level II randomized crossover study compared clinical outcomes (change in Epworth Sleepiness Scale [ESS], adherence, and subjective preference) between patients randomly assigned fixed CPAP based upon a single night APAP titration or to chronic APAP therapy. There was no difference in improvement of ESS or measures of adherence, but APAP was more often the preferred treatment. Additionally, one Level I crossover design study compared PSG-directed CPAP titration in patients with moderate to severe OSA with three different APAP devices during PSG over 4 consecutive nights. The devices using flow limitation in addition to vibration to determine pressure changes performed similarly to CPAP; the device using only vibration did not perform as well. There was no significant difference in control of the apnea hypopnea index (AHI) between CPAP and two of the APAP units tested (both algorithms based on flow limitation plus vibration), but there was one APAP unit that achieved significantly less control of AHI and arousals (vibration only). The maximum, mean, and 95th percentile pressures also varied between one of the APAP devices and the other two. Lloberes et al compared nighttime PSG-directed CPAP titration with daytime PSG- and APAP-directed pressure titration. They found that daytime APAP-directed titration yielded a higher treatment pressure recommendation than PSG-directed methods but that the clinical outcomes for ESS and PAP adherence were similar. All reviewed studies were performed in patients with moderate to severe OSA; there are no data for use in patients with mild OSA.

Several studies evaluated the differences in therapeutic pressure determinations between differing APAP devices (2 Level I, 1 Level II). One study compared the 50th and 95th percentile pressure levels during one night of PSG in patients with OSA and found differences between a flow-sensing device and a forced oscillating technique device. Another study found that the 95th percentile was higher with a flow-sensing device than with a forced oscillating technique device (9.9 vs. 7.0 cm H2O). The same was true for the 50th percentile pressures, and additionally, downloaded pressure tracings were visually different. This study was limited in that it did not provide any measure of sleep or actual control of breathing events. Together, these three studies do not actually provide an evaluation of these measures for choosing a fixed CPAP level, but they provide evidence that use of percentile measures to determine effective pressure levels may have inherent limitations and be device specific. Evidence for APAP titration is specific to each device, including the particular version of software and device version. Additionally, as pointed out in the prior review, the optimized treatment pressure is not necessarily the pressure below which 95% of all titration pressures fall (the 95th percentile). This is because a single night of titration may not find an adequate sampling of body position and sleep stage for pressure to be selected purely on a percentile basis. Just as in technician-directed PAP titrations, a careful review of the whole PSG is recommended to determine the optimal pressure.

3.5. Certain APAP devices may be initiated and used in the self-adjusting mode for unattended treatment of patients with moderate to severe OSA without significant comorbidities (CHF, COPD, central sleep apnea syndromes, or hypoventilation syndromes). (Option)

This is a change from the prior practice parameter paper. The prior practice parameter (3.6) stated that use of unattended home APAP treatment “in CPAP-naïve patients is not currently established.” Our present review found 5 Level I14-23 and 6 Level II24-28 studies pertinent to this treatment strategy. The reviewed evidence did not address patients with milder OSA (all subjects with AHI>15, except in one study with AHI>10). The studies, although of increasing methodologic soundness, have strengths and weaknesses in addressing this parameter.

In general, all study populations were predominantly male with moderate to severe OSA and without central sleep apnea, CHF, COPD, or other disorders associated with hypoventilation. Five studies evaluated patient groups that were completely CPAP naïve (1 Level I and 4 Level II), and four (2 Level I, and 2 Level II) evaluated patients exposed only to CPAP titration but otherwise unfamiliar with CPAP therapy. In two studies, the study subjects were not CPAP naïve prior to APAP use, and the meta-analysis19 was heterogeneous in this respect. One study selected only patients requiring fixed CPAP >10 cm H2O, and one study recruited patients with high variability in pressure requirements during CPAP titration. Another study compared APAP to treatment with titrated BPAP in patients with “difficult to treat” OSA, defined as (1) CPAP >12 cm H2O, (2) intolerance of CPAP treatment during one attended full-night CPAP titration, or (3) baseline central respiratory disturbances comprise ≥10% of the AHI, which increased further under CPAP. Four protocols started APAP at home after in-laboratory PAP titrations but did not use the information gained in setting the APAP device settings.14,20,29,30 One study initiated therapy at home after clinic instruction in APAP use in half of the patients and initiated APAP use in the hospital in the remainder. One was a meta-analysis that did not state the conditions under which patients were started on APAP. There was no significant difference in outcome of the four studies (1 Level I9, 3 Level II24,25,28) that assessed the effect of APAP vs. CPAP on improvement of AHI after 2 to 24 months of therapy. Of six studies evaluating improvement in ESS, 5 found no difference14,19,24,25,28 and 1 found slightly more improvement29 in patients using APAP vs. fixed PAP. In four crossover studies, the majority of patients preferred treatment with APAP vs. fixed PAP. Overall, most studies document similar compliance between CPAP and APAP. Only one study showed superior compliance in patients using APAP vs. CPAP. Mean pressures were consistently lower with APAP vs. CPAP, but in one study, the 95th percentile pressure of APAP after 6 weeks exceeded the fixed CPAP pressure determined by 1-night home APAP titration. There were also similar outcomes for improvement in measures of quality of life. Taken together, these studies form an increasing body
of evidence indicating that in populations resembling those tested and using specific devices, there is substantial clinical equivalency between home-initiated chronic APAP therapy and attended in-lab titrated PAP guided therapy for treatment of patients with moderate to severe OSA.

3.6. Certain APAP devices may be used in an unattended way to determine a fixed CPAP treatment pressure for patients with moderate to severe OSA without significant comorbidities (CHF, COPD, central sleep apnea syndromes, or hypoventilation syndromes). (Option)

This is a new practice parameter. The findings of the prior review7 included one Level II1 and 4 Level IV32-35 studies that related to unattended APAP titrations to determine a fixed CPAP treatment level. One Level IV34 study using a device no longer clinically marketed was not successful in finding an effective pressure (Peff), but three Level IV32,33,35 studies and one Level II31 study found 1-2 days of unattended APAP titration effective in arriving at an Peff comparable to PSG-directed CPAP titration (PSG-CPAP). Berkani et al (Level IV) and Fletcher et al (Level IV) applied APAP in an unmonitored setting to CPAP naive patients found that the derived Peff brought the AHI ≤10 in 80% and 77.7% of patients. Series et al (Level IV) found Peff from 1 or 2 weeks of unattended APAP titration similar to Peff from PSG-CPAP titration. Finally, Lloberes et al (Level II) found that a partially attended (in hospital, with the possibility of a nurse correcting mask fit if noted) APAP titration yielded equivalent Peff to attended PSG-CPAP derived Peff. In this latter study, the authors emphasized the importance of visual scoring of the pressure recordings to determine Peff.

The updated search found additional supportive evidence (3 Level I,19,22,36 3 Level II,30,37,38 1 Level IV39). One Level I study randomized patients to three different titration methods: PSG-CPAP, unattended APAP titration for 1-3 nights, or a formula-driven empirical pressure that was subsequently adjusted based on clinical variables38. Patients in all three groups received standardized instruction and 20 minutes of exposure to CPAP during an afternoon session for mask fit and acclimatization. Successful unattended titration of APAP required a minimum of 1 night with at least 6 hours of total recording, and at least 5 hours with a mean mask leak <0.4 L/sec. Successful titration was accomplished in 1-3 attempts in 96% of 119 patients. Peff was determined visually by inspection of raw data with a low leak and was taken as the 90th percentile pressure from those segments. This study did not directly compare treatment pressures between methods within the same patient, but instead compared clinical outcomes when treatment was based on different titration methods. There was no statistical difference in the AHI, arousal index, oxygenation during sleep, ESS, PAP adherence, or Functional Outcomes of Sleep Questionnaire (FOSQ) scores between groups titrated with APAP vs. PSG-CPAP, but the physical and mental axis of the SF36 and the EuroQol Index (a non-disease specific instrument for measuring health-related quality of life) improved slightly less in APAP titrated patients compared with PSG-CPAP titrated patients. This study provided the strongest support for this parameter. Senn et al studied 29 patients in a randomized crossover trial comparing 1 month of therapy on a fixed CPAP setting derived as the 90th percentile of pressure from 2 weeks of APAP with 1 month of therapy using two different APAP devices. Subjective and objective measures of sleepiness improved similarly in all three treatment arms, and a cardiorespiratory study at the end of the treatment period found all three treatment modalities provided good and similar control of apneas, hypopneas, and oxygenation parameters. However, this study did not compare outcomes in patients treatment with APAP directed CPAP settings to those of patients treated with CPAP settings determined by PSG. The meta-analysis by Ayas contains reference to APAP-directed CPAP settings, but was not designed to directly assess this use of APAP.

The studies reviewed for this review show equivalence in some, but not all parameters in patient outcomes when titration was based on unmonitored APAP as compared with PSG-CPAP titration. The available evidence supporting this practice is improving, but several issues remain to be settled. The required duration of APAP monitoring required, the best particular derived pressure (i.e., 90th percentile, 95th percentile, etc.), and which APAP algorithms and software provide accuracy all remain to be determined in most cases. It is important to stress that the cited evidence was specific to each device (devices are listed in the evidence table), including the particular version of software and device version, and that pressure determination should be made by experienced sleep specialists after examination of the raw pressure titration data for each patient. For these reasons, the committee did not find consensus that the available evidence supported a guideline recommendation. Polysomnography directed CPAP titration is still the standard method for determination of effective CPAP pressure.

3.7. Patients being treated with fixed CPAP on the basis of APAP titration or being treated with APAP must have close clinical follow up to determine treatment effectiveness and safety. This is especially important during the first few weeks of PAP use. (Standard)

This is in agreement with the prior practice parameter (labeled [7] in the prior document).6 Methods to assess the patient may include questionnaires measuring sleepiness and continued snoring, follow-up polysomnograms and cardiorespiratory studies, assessment of physical conditions such as an increase in weight, and capturing information stored on the APAP or CPAP devices, including time on device, time at pressure, pressure and leak profiles, and residual apneas/hypopneas (if available). As noted in the recent CPAP and BPAP therapy practice parameters article, there are data to suggest that follow-up soon after initiating PAP is associated with better outcomes of long term adherence.1 While this has not been explicitly evaluated in patients using APAP, the same admonition seems reasonable.

3.8. A reevaluation and, if necessary, a standard attended CPAP titration should be performed if symptoms do not resolve or if the APAP treatment otherwise appears to lack efficacy. (Standard)

This is unchanged from the prior practice parameter (labeled [8] in the prior document).6 Unresolved clinical symptoms should prompt a clinical reevaluation with attention to issues
such as mask fit, mask leak, use of device, weight change, and other clinical observations. A download of information from the APAP devices may reveal useful information, such as excessive mask leak, or an excess of apneas or hypopneas, which may guide decisions for further evaluation or treatment. If necessary, a standard in-laboratory CPAP titration with polysomnography should be performed to document or determine the efficacy of the CPAP or APAP treatment.1,40

4.0 AREAS FOR FUTURE RESEARCH

4.1 In order for APAP to better apply to usual clinical circumstances, studies are needed that clarify which patients can and cannot be served by APAP devices, with particular attention to subjects with mild OSA or comorbidities.

4.2 Since different technologies are used, at times with variable results, further research may be able to determine which technologies are most appropriate for specific patient groups. Development of industry standards in design, technical performance against standard flow profiles, and reporting would be beneficial and would assist practitioners in recognition and understanding of the underlying technologies.

4.3 The optimal way to derive the P_eff from attended and unattended APAP titrations is not standardized. More research is needed to determine which parameters are most important, how much mask leak is tolerable, and what durations of monitoring provide the best titrations. Similarly, since most available research does not find pressure a major determinant of patient acceptance and adherence, defining which patient specific factors will be most predictive of significant gains with APAP is of importance in deciding patient assignment to treatments.

4.4 Economic evaluations involving the use of APAP in titration or chronic therapy compared with PSG-CPAP, oral appliances, or surgery are few or lacking. The place of APAP therapy in the sleep specialist’s armamentarium is dependent on a better understanding of cost-benefit analysis of using these advanced technologies.

4.5 Most APAP devices have accompanying software that allows downloading of series data to a computer. The parameters reported vary from device to device, and the best use of the parameters is not yet the subject of research. Study is needed to validate the accuracy of certain parameters (e.g., APAP-determined residual AHI). Study may also illuminate which parameters are most helpful in guiding therapy, so that those factors can be standardized.

REFERENCES


3. Ryan CF, Lowe AA, Li D, Fleetham JA. Magnetic resonance imaging of the upper airway in obstructive sleep apnea before and after chronic nasal continuous positive airway pressure therapy.[see comment]. Am Rev Resp Dis 1991;144:939-44.


<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Grade</th>
<th>Problem</th>
<th>Intervention/Comparison</th>
<th>Study Design</th>
<th>APAP Attended/Unattended</th>
<th>Protocol</th>
<th># of Patients/Subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayas (2004)</td>
<td>1a</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG directed CPAP therapy</td>
<td>Meta-analysis of 9 RCT's—NB: 3 were cross-over and 6 parallel design</td>
<td>Unattended</td>
<td>The study was a statistical study so the protocol is implied but not stated and, presumably, involves subjects given an APAP and given “standard CPAP”—presumably PSG-derived but this is not explicitly stated.</td>
<td>282</td>
<td>Mean ranged from 27/hr to 59/hr—implying that subjects with mild OSA were not studied.</td>
<td>Primary Outcomes: 1) No difference in post-treatment AHI’s—data were homogenous; 2) No difference in post-treatment ESS’s—again, homogenous data; 3) APAP was associated with a lower mean pressure cf’ed with CPAP (2.2 cm H2O diff’c)—heterogeneous data; random effects model used to compensate for heterogeneity; 4) No significant difference in adherence bet. CPAP and APAP—heterogeneous data; Secondary Outcomes: 1) Correlates for greater reduction in mean pressures a) greater reduction in more recent studies; b) greater reduction in studies with more women; c) greater reduction in studies with younger subjects; 2) Correlates for better compliance: a) studies with a lower mean age showed greater compliance with APAP vs. CPAP—no correlation with adherence difference and mean CPAP pressure nor difference between CPAP/APAP pressures</td>
</tr>
<tr>
<td>Ficker (2003)</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG, Standard PSG directed CPAP therapy</td>
<td>Randomized parallel groups</td>
<td>Attended</td>
<td>After in lab PSG patients randomly assigned to FCPAP or APAP FOT in lab for 3 consecutive nights. Epworth Sleepiness Scale used pre and post. Researchers blind to which treatment. Subject no blind to machine type.</td>
<td>100</td>
<td>&gt;10</td>
<td>There was no difference between Epworth Sleepiness Scales between patients on FCPAP vs APAP (FOT). Mean pressure was lower on APAP than it was on CPAP.</td>
</tr>
<tr>
<td>Hertegonne (2003)</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP monitored and unmonitored/Other APAP device comparison</td>
<td>Randomized Crossover</td>
<td>Attended during use, but not monitored by sleep study/</td>
<td>Recruited all patients tested with AHI&gt;20 and arousals index&gt;30. After about 3 months habituation to empirical FCPAP, invited to hospital for randomized assignment to first one APAP device X 3.5 hr, then the other for 3.5hrs. Subjects blinded to nature of the devices. Studied tolerance with VAS, evaluated/compared pressure profiles obtained by download to individual proprietary software</td>
<td>Enroll:50</td>
<td>Compl:50</td>
<td>58.7±34.9</td>
</tr>
<tr>
<td>Author (Year)</td>
<td>Oxford Grade</td>
<td>Patient or Problem</td>
<td>Intervention/Comparison Intervention</td>
<td>Study Design</td>
<td>APAP Attended/unattended</td>
<td>Protocol</td>
<td># of patients/subjects</td>
<td>AHI</td>
<td>Primary Study Outcomes</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>--------------------</td>
<td>--------------------------------------</td>
<td>--------------</td>
<td>--------------------------</td>
<td>---------</td>
<td>------------------------</td>
<td>-----</td>
<td>------------------------</td>
</tr>
</tbody>
</table>
| Hukins (2004) [#154] | 2b because of power | Patients diagnosed with OSA | APAP unmonitored (home situation)/Standard PSG directed CPAP therapy | Randomized, single-blinded, parallel crossover | Unattended | Inclusionary criteria: CPAP-naïve subjects with an AHI >=5/hr and EDS. Subjects were given an Autoset T machine set in either APAP (pressure range 4-20 cmH2O) or fixed mode for 2 months and then RTC to have the machine mode adjusted, data retrieved, and fill out forms. Subjects were blinded. Primary end-pts: compliance, ESS, SF-36. Secondary end-pts: VAS measures of ease of Rx, attitude to RX, and side effects; pressures; leaks | 55 enrolled 46 completed | 59.7 +/- 30.1 and 50.2 +/- 24.9 for the two groups | 1. compliance a. no stat sig’t diff’ce in nightly hh of use (CPAP:4.86 +/- 2.65; APAP 5.05 +/- 2.38 hh/n—p=0.14) b. no stat sig’t diff’ce in % nn used (CPAP: 78% +/-32.6%; APAP 83.3% +/- 23.3%—p=0.29) c. compliance correlated—those who complied with one mode, complied with the other mode; d. in those subj’s who reported any SIDE EFFECT, compliance was higher with APAP than CPAP at p<0.001 2. ESS a. sig’t improvement cf’ed with pre-RX (p=0.001) b. no sig’t diff’ce bet. RX modes 3. SF-36 a. sig’t improvement in Role Physical and Vitality scores cf’ed with baseline (p<0.05) b. no sig’t diff’ce bet. RX modes in those scores 4. VAS a. ease of use—no stat’l diff’c b. subj’y attitude—no stat’l diff’c 5. Side Effects and unplanned visits a. fewer side effects in APAP (p=0.02) 6. Pressure Levels and Leaks a. 95th %-ile—lower in APAP (9.7 +/- 3.2 vs. 11.1 +/- 4.0 p=0.001) b. median %-ile—lower in APAP (7.5 +/- 3.1 vs. 11.0 +/- 3.9 p<0.001) c. max pressures same (APAP=10.7 +/-3.6; CPAP=11.1 +/-4; p=0.29) d. leaks stat’y sig’ly lower with APAP for median leak/95th %-ile leak/max leak (p<0.001, p<0.001, p<0.05)
<table>
<thead>
<tr>
<th>Author</th>
<th>Oxford Grade</th>
<th>Patient or Problem</th>
<th>Intervention/Comparison Intervention</th>
<th>Study Design</th>
<th>APAP Attended/unattended</th>
<th>Protocol</th>
<th># of patients/subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lloberes,</td>
<td>NS</td>
<td>Patients diagnosed with OSA</td>
<td>APAP monitored and unmonitored/Standard PSG directed CPAP therapy</td>
<td>Prospective, controlled, but non-random assignment</td>
<td>Attended</td>
<td>Confusing. Subjects assigned in order of presentation to Autoset Daytime titration, Manual (FCPAP) daytime titration, and Conventional nighttime titration with Manual titration (FCPAP). Daytime titration was after sleep deprivation. Pressures needed across the three groups compared. Sleep architecture as well. Epworth Sleepiness Scale compared at 3 months clinical follow-up. Main focus of the paper was the difference in daytime versus nighttime titrations.</td>
<td>93</td>
<td>&gt;30, nonspecified number of subjects &lt;30</td>
<td>No difference in Epworth Sleepiness Scale scores among the three groups at 3 month clinical outcome measure. APAP pressure during day higher than Manual (FCPAP) daytime pressure, and conventional nighttime manual. (latter 2 not significantly different).</td>
</tr>
<tr>
<td>Marrone,</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG directed CPAP therapy</td>
<td>Randomized, single blind Treatment handed out blindly and randomly, but machines appeared different to subjects. Could one type of machine have looked better than the other?</td>
<td>Overnight CPAP titration done with autoCPAP to determine fixed CPAP pressure/Unattended APAP</td>
<td>Subjects with AHI of &gt;/= to 30 on diagnostic NPSG, underwent in lab titration study, where the fixed CPAP pressure was determined by autoCPAP. Subjects were then randomized to receive either fixed level CPAP or autoCPAP for a period of 4 weeks. They were then switched to the alternate machine for another 4 weeks. At the end of each 4 week block, BMI, ESS and a sleep questionnaire were completed at the end of each 4 week lab. Compliance data was downloaded from the machines</td>
<td>NR</td>
<td>68.4</td>
<td>1) Questionnaire about subjective preference, sleep quality: More subjects preferred autoCPAP 2) ESS-no difference 3) compliance higher in patients who indicated that preferred autoCPAP compared to those who had no preference</td>
</tr>
<tr>
<td>Author</td>
<td>Oxford Grade</td>
<td>Patient or Problem</td>
<td>Intervention/Comparison Intervention</td>
<td>Study Design</td>
<td>APAP Attended/unattended</td>
<td>Protocol</td>
<td># of patients/subjects</td>
<td>AHI</td>
<td>Primary Study Outcomes</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>-------------------</td>
<td>--------------------------------------</td>
<td>--------------</td>
<td>--------------------------</td>
<td>----------</td>
<td>------------------------</td>
<td>------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Marrone, (2005)</td>
<td>3b or 4 I say 3b because there were a very large number of subjects.</td>
<td>Patients diagnosed with OSA</td>
<td>APAP Monitoredd (in lab)/No comparison group</td>
<td>Overnight APAP attended.</td>
<td>Patients with OSA diagnosed by either NPSG or portable monitoring underwent an in lab titration study using autopap to determine a fixed pressure. 95th percentile CPAP was considered as the pressure level suggested by means of fixed level CPAP machines. All patients were CPAP naïve. Technician was present to help with mask issues. Reliability of titration was then assessed in 4 consecutive steps, taking into account pressure levels administrated by the device in association with: 1) oxygen desaturation alone 2) oxygen desaturation and time spent in the supine position 3) disordered breathing and time spent supine (looking at airflow, SaO2, position, respiratory montage) 4) respiratory and sleep characteristics. (all manually scored) Considered inadequate titration if TST &lt; 3hrs, no REM sleep, or less than 1 hour of supine position.</td>
<td>75</td>
<td>61.7 +/- 20.5</td>
<td><strong>Compared autocpap reliability during an in lab titration night by comparing events at each pressure with manual scoring of events (oxygen desaturations, airflow, respiratory montage). In 87.5% of cases, autocpap provided reliable information about pressure levels correcting respiratory disorders during sleep.</strong></td>
<td></td>
</tr>
</tbody>
</table>

Masa (2004)  
(#{168})  

<table>
<thead>
<tr>
<th>Oxford Grade</th>
<th>Patient or Problem</th>
<th>Intervention/Comparison Intervention</th>
<th>Study Design</th>
<th>Unattended</th>
<th>Protocol</th>
<th># of patients/subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
</table>
| 1b           | Patients diagnosed with OSA | APAP unmonitored (home situation)/ Standard PSG directed CPAP therapy | Multi-center, Prospective, randomized, controlled trial | Pts requiring CPAP with AHI≥30, ESS≥12 recruited from sleep centers. Each received 20 minute daytime CPAP trial and instruction, the randomized to PSG-directed CPAP, AutoPAP titration for 1-3 nights, or estCPAP by formula-subsequently adjusted by clinical parameters. Close follow up, and finally at 12 weeks, all patients underwent PSG on best CPAP and were assessed for outcomes. | 466 evaluated, 23% excluded, 199 patients randomized | 62.7 | **No difference in titration failures between standard and APAP groups (2.4% vs 4.2%)**  
**APAP titration achieved in 1 night in 82.4% of patients**  
**There was no statistically significant difference between titrated CPAP, improvement in AHI, other sleep parameters, oxygenation, or compliance at 12 weeks using either PSG-CPAP, or APAP titration.**  
**The AHI was a little higher using the empiric formula method.**  
**QOL measures improved in all groups**  
**In the APAP group, the degree of improvement in SF36 physical and EuroQol was lower than that in the PSG-CPAP group.**
<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Oxford Grade</th>
<th>Patient or Problem</th>
<th>Intervention/Comparison Intervention</th>
<th>Study Design</th>
<th>APAP Attended/unattended</th>
<th>Protocol</th>
<th># of patients/subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massie (2003) {#119}</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG directed CPAP therapy</td>
<td>Multisite, randomized, single blind, cross over study</td>
<td>APAP unattended/unattended</td>
<td>Symptomatic patients, age 18-65, with an AHI &gt; 15 and who required a CPAP pressure &gt; 10 on titration night were included. Patients were given autopap for 6 weeks followed by 6 weeks at fixed CPAP pressure. Primary and secondary outcomes as listed were assessed at the end of each 6 week limb.</td>
<td>46 patients enrolled. 44 patients completed the study</td>
<td>Greater than 15</td>
<td>1) Hours of use of CPAP vs APAP 2) Pressure given APAP vs CPAP 3) Residual AHI 4) SF-36 questionnaires 5) ESS 6) Days of use</td>
</tr>
<tr>
<td>Nolan (2004) {#163}</td>
<td>1b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG directed CPAP therapy Other APAP device comparison</td>
<td>Randomized cross-over Unattended</td>
<td>Long-term CPAP users were switched to APAP (press. range 4-16 cm H2O) and used each of the 3 machines for 4 weeks; the investigators were blinded but, clearly, the ss could not be but were not told that the machines worked diff’ly—only that they were newer machines. In addition to comparing the 3 APAP machines, ss were also monitored on their current CPAP machine, of which there were 4 diff’t models. Data collected: compliance, pressure, SF-36, ESS, side effects, preference. CPAP pressure mean=10 and range=8-12 cm H2O</td>
<td>27 48 (29-76)</td>
<td>1. compliance—no diff’ce bet. CPAP/Autoset/RemStar—less use with Breas for both % nn used and hh/n (p&lt;0.01); 2. mean pressure—Autoset/RemStar lower than CPAP (8 cm/7.3 cm vs. 10 cm) at p&lt;0.01 BUT Breas even LOWER than other three (5.3 cm) at p&lt;0.01 This is interesting because it suggests that lower pressure causes more discomfort—see item 6 below; 3. max. pressure—only sig’t diff’c was that RemStar was higher than CPAP (13.4 vs. 10) at p&lt;0.01 4. SF-36—no sig’t diff’c among all 4 machines 5. ESS—no sig’t diff’ce 6. Subj. eval. of APAP machines a. pressure discomfort more with the Breas vs. other 2 (p&lt;0.05) b. poorer sleep quality with Breas cf. other 2 (p&lt;0.05) c. least preferable in terms of size/noise=Autoset (p&lt;0.001) 7. Subj. pref’c—48% (13) chose to stay on CPAP; 52% (14) preferred APAP 6 chose REMStar/5 chose Autoset/3 chose Breas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author</td>
<td>Oxford Grade</td>
<td>Patient or Problem</td>
<td>Intervention/Comparison Intervention</td>
<td>Study Design</td>
<td>APAP Attended/Unattended</td>
<td>Protocol</td>
<td># of patients/subjects</td>
<td>AHI</td>
<td>Primary Study Outcomes</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>--------------------------------------------------------</td>
<td>-------------------------------------</td>
<td>------------------------------------</td>
<td>-------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Noseda, (2004)  | 2b           | Patients diagnosed with OSA                            | APAP unmonitored (home situation)/Standard PSG directed CPAP therapy | Single blind Randomized Prospective Crossover | Unattended              | 93 patients had undergone diagnostic and CPAP titration PSG, and were placed on APAP for 2 weeks with baseline 7, range 4-14. They used downloaded data to identify those with more variable “pressure requirements” based on a variability index derived from pressure-time domain. 24 patients were then randomized to FCPAP vs. APAP for 8 weeks, then crossed over to opposite limb for 8 weeks. Pittsburgh Sleep Quality Index and ESS collected at baseline and after each limb, and subjective preference for device collected at end of both limbs. Subjects not told which setting or type of setting was used. | 93 eligible, 3 refused, 90 completed 2 weeks APAP, from which 27 had highly variable pressure requirements. 24 completed the study. | 50.9±25.6 | -ESS was slightly better on APAP than FCPAP (5.1 ± 2.8 vs. 6.1 ± 2.8, p<0.01)  
-PSQI improved equivalently with both treatments  
-Compliance was similar in both groups: (5.5 ± 1.5 vs. 5.3 ± 1.9 FCPAP vs APAP, NS) and days used was 95.5% in both groups.  
-Mean Pressure was less with APAP (7.6 ± 2.3 vs. 8.5 ± 2.2 p<0.05)  
-16/24 preferred APAP therapy  
-median Apnea Index not statistically different (CPAP-0.40/h—range 0-2.4/h; APAP-0.45/h—range 0-5.8/h) | |
| Nussbaumer (2006) | 2b         | Patients diagnosed with OSA                            | APAP unmonitored (home situation)/APAP directed CPAP therapy | Randomized, double-blind, cross-over study | Unattended              | Pts with an AHI>10 based on HOME monitoring of resp’y parameters; prescribed either APAP for one month or CPAP using the APAP machine in the constant mode and using the P90 as determined by 1 night of APAP monitoring prior the trial period; pre-set press range=5-15. After each time interval, subjects underwent the following: home-based resp’y monitoring (7-channel—respirations + legs—no EEG) to evaluate AHI and ODI; ESS; SF-36; VAS of benefits/side effects (tolerance/preference); vigilance test (Osler test); compliance; measurement of pressures; sleep resistance. | 30 (34 enrolled) | 41.1 +/- 3.6 | 1) AHI—one APAP and CPAP reduced AHI by equivalent amounts (p<0.05 vs. baseline and p=NS between modes) and equivalence confirmed  
2) ODI—similar to above—equivalency between modes and significant change from baseline;  
3) ESS—fall in ESS equivalent;  
4) SF-36—only 1 domain showed improvement from baseline, the vitality score, and this was sig’y improved with either treatment;  
5) vigilance—significant improvement for both modalities; no significant diff’c between modalities;  
6) sleep resistance showed improvement from baseline and no sign’t diff’c between groups but equivalence could not be confirmed with pre-set measures;  
6) tolerance—noise perception and discomfort at high pressures were better tolerated with APAP; other sx’s showed no diff’c (sleep quality; side effects from mask; mouth leaks)  
7) preference—26/30 subjects favored APAP  
8) compliance—no sig’t diff’c in hours/noc  
9) mean pressure—lower with APAP than with CPAP with mean diff’c of 1.3 cm H2O. |
<table>
<thead>
<tr>
<th>Author</th>
<th>Oxford Grade</th>
<th>Patient or Problem</th>
<th>Intervention/Comparison Intervention</th>
<th>Study Design</th>
<th>APAP Attended/unattended</th>
<th>Protocol</th>
<th># of patients/subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palombini</td>
<td>4</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/No comparison group</td>
<td>Clinical Series</td>
<td>Unattended</td>
<td>Consecutive patients with stroke were enrolled in the study prior to PSG-determination of OSA. The study group is all patients who agreed to participate and had a sufficient level of consciousness. The study included agreement to use CPAP as well as subsequent dx of OSA by portable PSG and based on AHI&gt;=10. Of those who agreed to use CPAP and met criteria (n=14), auto-PAP was prescribed and they were evaluated sequentially over an 8-week period for compliance with secondary measures of ESS, NIH Stroke Scale, Barthel Index, as well as other questions that were reported without a measure (e.g., rate of nocturia, caregiver disruption, consolidation of nocturnal sleep).</td>
<td>32 enrolled; 7 completed</td>
<td>25.5 +/- 7.2</td>
<td>Compliance with nasal APAP in this patient population—7/32 =22% completed the study</td>
</tr>
<tr>
<td>Pevernage</td>
<td>1b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP monitored and unmonitored/Standard PSG directed CPAP therapy/Other APAP device comparison</td>
<td>Randomized crossover during split night</td>
<td>Attended</td>
<td>90.5 ± 69.2 dayshome habituation period, then split night with crossover of each device. Raters and patients blinded.</td>
<td>30 recruited; 30 completed</td>
<td>&gt;20</td>
<td>There was no difference between the devices except that the APAPflow (Autoset) was better than the APAPflow (Somnosmart) in decreasing snoring.</td>
</tr>
<tr>
<td>Author</td>
<td>Oxford Grade</td>
<td>Patient or Problem</td>
<td>Intervention/Comparison Intervention</td>
<td>Study Design</td>
<td>APAP Attended/unattended</td>
<td>Protocol</td>
<td># of patients/subjects</td>
<td>AHI</td>
<td>Primary Study Outcomes</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>--------------------</td>
<td>---------------------------------------</td>
<td>--------------</td>
<td>--------------------------</td>
<td>----------</td>
<td>-------------------------</td>
<td>-----</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Planes, C, et al. (2003) {105}</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG directed CPAP therapy</td>
<td>Randomized, not blinded</td>
<td>APAP initiated in home with minimum at 6 cmH2O, then after 1 week of recording, range set at peak pressure -4, +2 cmH2O.</td>
<td>Patients referred for suspected OSA and tested with PSG and found with AHI≥30, (&gt;80% obstructive events). Baseline ESS obtained (ESS): 14.8±4.9 Randomized to in-lab PSG guided NCPAP therapy vs. home APAP with nursing coach. After 2 months, patients tested with PSG, repeat ESS, objective compliance, patient subjective tolerance score.</td>
<td>35/16 APAP (2 drop out)</td>
<td>FCPAP:60.1±19.0 vs. APAP:56.2±16.1 h⁻¹</td>
<td>• AHI Arousal Index, Sleep architecture, CT90%, all significantly improved from baseline, but not different between NCPAP and APAP.</td>
</tr>
<tr>
<td>Randerath (2003) {#93}</td>
<td>1b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP monitored and unmonitored/Standard PSG directed CPAP therapy</td>
<td>Randomized crossover design</td>
<td>Unattended</td>
<td>Patients diagnosed with OSA, found to be intolerant of FCPAP or those requiring FCPAP ≥12 cm H2O on PSG-directed FCPAP, or those with central respiratory disturbances ≥10% of the AHI, or those with central apneas which increased further under CPAP were admitted to the study. These were then randomized to 27; 7 dropped out prior to completion of study, but analyzed as intention to treat</td>
<td>Baseline 24±27.3/h, BPAP=9.8±12.5/h (p&lt;0.01), and APAP=13.8±13.2/h (p&lt;0.01).</td>
<td>10% of total population was found to meet the “cpap intolerant group.”</td>
<td></td>
</tr>
</tbody>
</table>

*Practice Parameter for APAP—Morgenthaler et al.*
<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Oxford Grade</th>
<th>Patient or Problem</th>
<th>Intervention/Comparison Intervention</th>
<th>Study Design</th>
<th>APAP Attended/Unattended</th>
<th>Protocol</th>
<th># of Patients/Subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randerath, WJ, et al. (2001)</td>
<td>1b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP monitored and unmonitored/Standard PSG directed CPAP therapy</td>
<td>RCT, blinded, crossover</td>
<td>Unattended during therapy, attended during in-lab PSG</td>
<td>Referred patients diagnosed with AHI&gt;10/h. Received dx PSG, CPAP titration PSG, and two night PSG on FCPAP or APAP for baseline data. Patients then randomized to APAP vs FCPAP for 6 weeks, PSG, then other arm for 6 weeks, then PSG. Sleep variables, AHI, ESS, compliance collected, mean CPAP pressures at all 6 week intervals. Patient preference collected at end of trial.</td>
<td>52 patients enrolled, 47 completed. 2 each of APAP and FCPAP arms disenrolled, and 1 was removed from study when a new dx of cancer made.</td>
<td>35.1±26/h</td>
<td>• Both constant CPAP and APAP FOT improved AHI at both measuring time points. AHI decreased from 35.1±26/h (baseline) to 5.3±5.6 (APAP FOT-first night), 4.6±4.8 (FCPAP-first night), 5.0±5.2 (APAP FOT-6 wk) and 4.3±6.3 (FCPAP-6 wk) (p&lt;0.001 between baseline and each treatment mode) % of patients with AHI&lt;5 or 10 not provided. • Arousal frequency was significantly but similarly reduced by both APAP and FCPAP from baseline. Sleep architecture also improved from baseline and did not vary between treatment modalities. • Compliance was excellent and not different between APAP and FCPAP • Of 47 patients completing study, 35 (75%) preferred APAP FOT for long-term treatment at home, and 12 preferred FCPAP (p&lt;0.01). • Despite higher mean pressures for FCPAP than APAP by 2 cmH2O, there were no significant differences noted in side effects of therapy, which were all considered “mild” (actual percentage of side effects not provided).</td>
</tr>
<tr>
<td>Resta (2004)</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Standard PSG directed CPAP therapy</td>
<td>Randomized, single-blind with parallel control group</td>
<td>Unattended during intervention but end-point data collected in lab.</td>
<td>Pts referred w/un-rx’ed OSA were enrolled and prescribed either CPAP based on PSG titration or APAP (settings 4-16) for one month, at which point they were brought back to the lab and underwent PSG with their own machine, monitoring resp’y and sleep parameters. ESS and analysis of pressure and compliance over the past month was also done at that time. Preference was not assessed. The authors had done a prior study looking at ONE night of low pressures given via APAP and found increased sleep fragmentation. The question was whether or not CHRONIC use was associated with increased sleep fragmentation as well.</td>
<td>20 ss—10/RX group no drop-outs</td>
<td>RDI (includes RERAs): 45.3 +/-10.7 for CPAP, 48 +/-14.3 APAP</td>
<td>1. Sleep parameters—after treatment a. no sig’t diff’ces between treatment arms (e.g., AHI=7.3+/-3.3 (C) and 7.4+/-2.3 (A))—analyzed TST; sleep eff%; % of each stage b. sig’t improvements cf’ed with baseline for both RX arms for AHI (p&lt;0.001)—other parameters showed improvements but p-levels not specified 2. Resp parameters—after treatment a. no sig’t diff’ces bet. RX arms (RDI=8.4+/-3.6 (C);8.3+/-2.0 (A)) b. sig’t improvement cf’ed with baseline at p&lt;0.001 3. ESS—NS diff’c bet. RX’s (4.1 +/-1.4 (C);2.5+/-1.9 (A)) 4. mean pressure manually titrated (10.8 +/-1.7) and 95th %ile f’up night PSG (10.1 +/-1.3) correlated with p&lt;0.005 (NS diff’c also when cf’ing above with 95th %ile used at home, as well) 5. compliance “similar” (5.3 +/-1.8 (C);5.2+/-1.4 (A))</td>
</tr>
<tr>
<td>Author</td>
<td>Oxford Grade</td>
<td>Patient or Problem</td>
<td>Intervention/Comparison Intervention</td>
<td>Study Design</td>
<td>APAP Attended/unattended</td>
<td>Protocol</td>
<td># of patients/subjects</td>
<td>AHI</td>
<td>Primary Study Outcomes</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------</td>
<td>--------------</td>
<td>--------------------------</td>
<td>----------</td>
<td>-------------------------</td>
<td>-----</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Senn (2003)     | 1b           | Patients diagnosed with OSA-does not report how | APAP unmonitored (home situation)/not say Other APAP device comparison, APAP-directed FCPAP | Single blind randomized crossover | Unattended | Subjects who were diagnosed with sleep apnea were sent home for two weeks on AutosetT, or AutosAdjust LT. The 90th percentile pressure was used as subsequent FCPAP pressure. Patients were then randomized to either FCPAP or APAP, in a crossover fashion with each subject on each condition at home for one month. Subjects blind to purpose of study but were aware that different modes were being used. Epworth Sleepiness Scale and quality of life investigated. Modified MWT (Osler) test used to measure differences. | 31 (29 remained) | >10, otherwise not specified. | • Every one had equal improvement in symptoms.  
• Both APAP conditions showed lower mean pressure than the FCPAP.  
• 95th percentile pressure for both APAP devices was higher than FCPAP, but not surprising since FCPAP was derived as 90th percentile over first 2 weeks.  
• Pressure variability was more with AutoAdjust LT than with AutosetT.  
• Effect of all three conditions on Epworth Sleepiness Scale and other measures was the same; all improved from baseline equally.  
• No special characteristics of any patients who preferred one treatment over the other. No effect of condition on compliance. |
| Stammnitz      | 1b           | Patients diagnosed with OSA       | APAP Monitored (in lab)/Standard PSG-directed CPAP therapy Other APAP device comparison | prospective controlled randomized crossover design | Attended   | Patients recruited pseudo-randomly from those completing diagnostic PSG and with AHI $\geq$10 hr$^{-1}$. All patients underwent PSG-directed FCPAP titration second night. Patients then treated on 4 subsequent nights for 1 night on randomly assigned FCPAP, AutoSet, Horizon, or Virtuoso during PSG. | 16/12=(16 entered) - (4 drop out) | 67.3±21.7 hr$^{-1}$ | • Mean AHI was significantly decreased with FCPAP and each APAP  
• AHI with the AutoSet and Horizon devices was significantly lower than with the Virtuoso  
• Treatment AHI$<5$ h$^{-1}$ seen in all patients using FCPAP, 10/12 using Horizon and AutoSet, 6/12 using Virtuoso  
• TST was same between nights (devices), and all devices showed increase in %SWS and %REM compared with diagnostic PSG  
• No differences in total arousal index between FCPAP and the 3 APAP devices, but respiratory arousals in Virtuoso>(AutoSet or Horizon) > FCPAP (p<0.05).  
• Mean arousals associated with pressure changes in APAP devices similar, range 0.8–1.3 arousals/hr.  
• Oxygenation parameters similar in all treatment groups  
• mean pressure with fixed CPAP and Horizon  
• Mean FCPAP= 9.9±1.8 cmH2O and and was 8.5±2.8 cmH2O (no signif difference), but mean pressure significantly lower with AutoSet (7.3±1.6 cmH2O) and Virtuoso (6.5±2.3 cmH2O), % time with pressure>FCPAP pressure was similar between APAP machines.  
• Technicians intervened to reduce mask leak. In 3 patients, dropout was attributed to mask leak that would not have been detected without technician observation. |
<table>
<thead>
<tr>
<th>Author</th>
<th>Oxford Grade</th>
<th>Patient or Problem</th>
<th>Intervention/Comparison Intervention</th>
<th>Study Design</th>
<th>APAP Attended/unattended</th>
<th>Protocol</th>
<th># of patients/subjects</th>
<th>AHI</th>
<th>Primary Study Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>West, SD, et al. (2006)</td>
<td>2b</td>
<td>Patients diagnosed with OSA</td>
<td>APAP unmonitored (home situation)/Chronic APAP compared with APAP-directed CPAP and empiric CPAP</td>
<td>RCT-double blind</td>
<td>Unattended</td>
<td>98 patients recruited at convenience out of 633 patients started on CPAP in Oxford, Jan 02–Mar 03. Subjects had diagnosis of OSA made on basis automated portable monitor utilizing pulse transit time (Win-Visi Monitoring System), oxygen desaturation index &gt;10, ESS&gt;9, and “preference” given to local patients to ease follow up logistics. Randomized to receive chronic APAP, FCPAP directed by using 95%ile pressure determined by 1 week of APAP, or FCPAP set as determined by algorithm equation. Outcome variables (ESS, OSLER-MWT, SF-36, SAQLI, ambulatory 24 hr BP) assessed at baseline, 1 month, and 6 months, with follow up provided by sleep nurses.</td>
<td>98/6 months variable pressure (n=31)/1-week variable pressure, then fixed pressure (n=33) / 6 months algorithm derived fixed pressure (n=34)</td>
<td>NA; desaturation index &gt;10; median 34.5 dips per hour, range 10.3–89.0</td>
<td>ESS, OSLER-MWT, SF-36, SAQLI all improved significantly (p&lt;0.05), but there was no significant difference between groups in improvement. Median and 95%ile pressures between groups differed significantly, with lowest median pressures and highest 95%ile pressures in the Chronic APAP group.</td>
</tr>
</tbody>
</table>