Nonattended home automated continuous positive airway pressure titration: Comparison with polysomnography

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OBJECTIVE: **Automatic adjusting nasal continuous positive airway pressure titration (APAP) has been introduced as an alternative method of establishing pressures for patients with sleep apnea. The performance and accuracy of APAP in nonattended home environment are controversial. This study assessed APAP polysomnographic outcomes and accuracy in a nonattended home environment.**

STUDY DESIGN AND SETTING: **We conducted a retrospective consecutive case series of 24 consecutive patients who had nonattended APAP and simultaneous full polysomnography (PSG).**

RESULTS: **APAP was tolerated and reduced obstructive Apnea-Hypopnea Index (AHI) to <10 events/h in all patients. Mean AHI decreased from 38.4 (21.2) to 5.9 (6.6) events/h. Central apneas worsened in one patient. A therapeutic pressure was determined in 91% of patients. Autoset accurately measured residual AHI compared with PSG ($R = 0.77$, $P < 0.001$). APAP overestimated the AHI by 1.4 events/h.**

CONCLUSIONS: **Nonattended APAP is successful in many patients in determining a therapeutic positive pressure setting. Reported AHI via Autoset is similar to that of PSG.**

SIGNIFICANCE: **APAP reduces AHI and is tolerated in a nonattended environment.** (Otolaryngol Head Neck Surg 2003;128:353-7.)

The obstructive sleep apnea syndrome (OSAS) is a common disorder that has been shown to be associated with significant cardiovascular morbidity.[1,2] Diagnosis is made using polysomnography (PSG), and the initial treatment is usually the use of nasal continuous positive airway pressure (CPAP). The conventional method of determining the level of fixed nasal CPAP for the treatment of OSAS is attended laboratory titration with simultaneous PSG.[3] Historically, nasal CPAP titration has been performed as a single-night study after a complete full night diagnostic sleep study. More recently, diagnostic sleep study and CPAP titration have been performed in a single night using split-night protocol.[4] In these studies, the diagnostic portion is done in the first hours of sleep followed by the therapeutic nasal CPAP titration. Critics of nonattended polysomnographic CPAP titration argue that double-night or split-night studies in the sleep laboratory provide critical technician and patient interactions.[5] These include instructional advice on nasal CPAP, mask adjustments, reapplication of monitoring leads, or addressing life-threatening emergencies.[6]

Novel methods of nasal CPAP titration using automatic adjusting nasal CPAP, or "auto-PAP" (APAP), have been introduced as an alternative to attended laboratory titration.[7-9] Nasal APAP devices automatically select pressures without technician intervention. There have been several reports in the literature that studied the efficacy and use of this machine in the laboratory.[10,11] Automated nonattended titration of nasal CPAP has the benefit of multiple night titration for patients. Pressure adjustments can also be addressed for long-term therapy or for changes in medical condition. Without the need for technician intervention, this less expensive nonattended diagnostic sleep apnea testing becomes more accessible to patients with significant health care economic implications.[12]

Nonattended home testing and nonattended therapy have been controversial in the sleep community, in part because few reports have compared simultaneous PSG with unattended APAP.[8] Automated nonattended titration of nasal CPAP

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Presented at a meeting of the Association of Professional Sleep Societies, Las Vegas, NV, June 2000.

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0194-5998/2003/$30.00 + 0
doi:10.1067/mhn.2003.35

has been validated in a controlled laboratory setting.[13] Autoset (Resmed, San Diego, CA) has already demonstrated equivalent titration of CPAP pressures to that of an attended laboratory titration, and OSAS outcomes have also been shown to be equivalent between the 2 modes of treatment for long-term home use.[11,13] However, the effectiveness is questioned in an unattended setting, especially for patients who have had limited or negative exposure to positive pressure therapy. It is the goal of this current study to retrospectively examine the clinical performance (adequacy of therapy and accuracy of device reports) in a nonattended home setting using an APAP device (Autoset) and to compare it with simultaneous 16-channel PSG.

METHODS

Twenty-four consecutive patients from the Sleep Disorder Clinic at the Medical College of Wisconsin who underwent simultaneous PSG with unattended home APAP were retrospectively reviewed. The PSG included 4-channel electroencephalography, 2-channel electro-oculography, submental and anterior tibialis electromyography, nasal oral airflow, 2-channel respiratory effort, oxygenation saturation, electrocardiography, and body position monitoring (Digitrace, Boston, MA). Patients undergoing nonattended APAP titration were untreated and either had a nonattended PSG without CPAP titration (n = 16) or had undergone a traditional laboratory PSG (n = 8) without CPAP trial. OSAS was defined as having an Apnea-Hypopnea Index (AHI) of >5 events/h. One patient who was suspected of having sleep-disordered breathing (AHI < 5 with sleepiness) and possible "upper airway resistance syndrome" was also titrated with APAP. Obstructive apnea was defined as a complete cessation of airflow for 10 seconds or longer with continued respiratory effort. Hypopnea was defined as a clear reduction in airflow from baseline associated with a 2% reduction in oxygen saturation or an electroencephalographic arousal. Diagnostic PSG was performed separately and preceded therapeutic studies. Pretreatment diagnostic polysomnograms included both attended and nonattended studies. Attended studies were performed in different community laboratories with resultant varied recording methods and polysomnogram interpretation. Nonattended sleep studies were performed by the same personnel using similar techniques; these techniques had been validated in previous studies.[14]

Nasal APAP titration was performed with Autoset Plus 2 in a therapeutic APAP mode. In addition to titrating CPAP pressures, this APAP device measured residual AHI and mask leak. Residual AHI was automatically recorded into part of the device's algorithm.

Patients underwent polysomnographic setup at the medical office in the afternoon or evening of the planned study. After application of the electrodes, patients were instructed in the use of the APAP machine. The CPAP masks (Mirage; Resmed, San Diego, CA) were fitted by our staff to ensure a correct fit. No inline humidifiers were used.

Data for all of the patients were collected and compared from printed reports of the therapeutic PSG and APAP. In addition, Respiratory Disturbance Index (RDI), total obstructive apneas, total central apneas, and periodic leg movements results from both pretreatment and APAP treatment nights were compared for patients evaluated and scored with comparable nonattended studies. Data were evaluated and compared using paired and nonpaired Student's *t* tests.

RESULTS

APAP and posttreatment polysomnographic results were available for 23 patients (19 men and 4 women; mean age, 48.7 (12.7 years). Nasal APAP titration records for 1 patient were not available and were excluded. The 23 patients had a mean posttreatment AHI of 6.5 (8.2 events/h. Ninety-one percent (21 of 23) of the patients had an AHI of $\leq$10.

Sixteen patients had the same pretreatment/posttreatment nonattended PSG (Table 1). Apnea severity varied from mild to severe with a mean pretreatment AHI of 38.4 (21.2) events/h (range, 7.3 to 71.2) and a mean pretreatment lowest oxygen desaturation of 70.4 (24.8%). The mean posttreatment AHI was 5.9 (6.6) events/h (range, 1.1 to 27.9). Nasal APAP titration successfully reduced AHI (Fig 1).

Table 1. Data for 16 patients with identical nonattended 16-channel polysomnography is shown

	Pretreatment	Posttreatment	*P* value
PLM	12.8	33	>0.05 (NS)
Obstructive apnea (total)	103	1.7	0.001
Central apnea (total)	11.1	15.7	0.05 (NS)
AHI (PSG)	38.4	5.9	0.001

PLM, Period leg movement; *AHI*, Apnea-Hyponea Index; *PSG*, polysomnography.

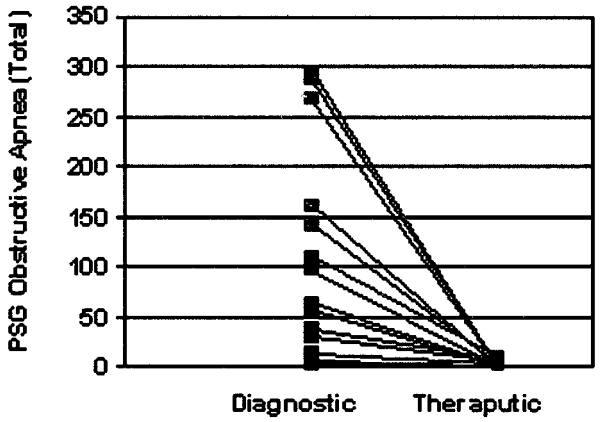

Fig 1. Obstructive apnea data from pretreatment and posttreatment polysomongraphy (PSG) are shown (AHI = apnea hypopnea index)

Table 2. Post-treatment Apnea-Hypopnea Index and mask leak

	PSG	APAP	*P* value
AHI	6.5	7.9	<0.01
ML* <0.02 L/s	NA	61.30%	
ML <0.05 L/s	NA	92.60%	

AHI, Apnea-Hypopnea Index; *ML*, mask leak; *PSG*, polysomnography; *APAP*, automatic adjusting nasal Continuous positive airway pressure; *NA*, not applicable.
*ML given in percent of total recording time.

To assess the validity of the device algorithm in identifying residual events in the 23 patients, results of the APAP device and simultaneous PSG were compared. The nasal APAP titration machine overestimated the AHI compared with PSG by an average of 1.4 events/h (6.5 [8.2] versus 7.9 [7.4] events/hr) (Table 2). The nasal APAP titration AHI correlated highly with the polysomnographic AHI ($R = 0.77$, $P < 0.0001$) (Fig 2). One patient demonstrated 47 central apneas on the initial PSG, which increased to 192 central apneas without desaturation during the nasal CPAP titration (Fig 3). The nasal APAP titration device correctly identified the occurrence of these respiratory events. All studies were successful, with no mask leak or mask intolerance (Table 2). A maximum mask leak of < 0.5 L/min was observed in 93% of patients, and a maximum leak of < 0.2 L/min occurred in 62%.

DISCUSSION

The purpose of this retrospective study was to evaluate the performance of APAP in an unattended clinical setting. Using a protocol with appropriate nasal CPAP masks and CPAP instruction enabled all studies to be well tolerated by the patients. The AHI was significantly reduced in all patients.

In 1 patient, there was significant worsening of central apneas. Central apneas may occur in any OSAS patient who is rapidly titrated with a nasal CPAP. Central apneas that are observed during the initial PSG resolve with ongoing treatment in many patients. Often, central apneas are increased in frequency at higher levels of applied positive pressure, which might be avoided by reducing high CPAP pressures. In this study, APAP was set at an upper threshold of 20 cm H_2O, and it was at this higher pressure that most central events occurred. It may be possible to reduce the probability of central apnea by limiting the upper threshold to 15 cm H_2O. The central events observed in our study were not associated with oxygen desaturation, and the APAP device correctly identified residual respiratory events.

In some patients, periodic leg movements (PLMs) were increased during the APAP therapy. Similar observations are seen during laboratory-attended PSG. The clinical consequence of increased PLMs is unknown. For asymptomatic patients, PLMs do not require treatment and may be an epiphenomenon.

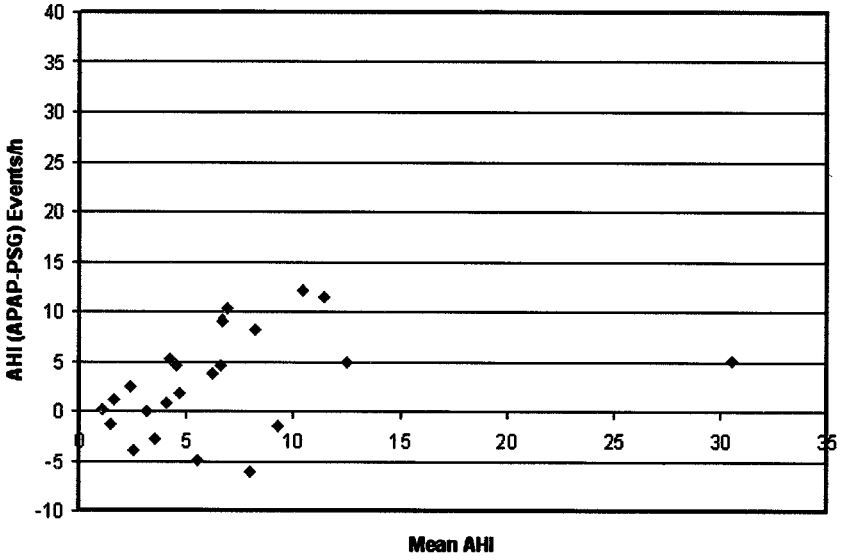

Fig 2. Bland Altman plot demonstrating differences in APAP and PSG AHI (APAP = automatic adjusting CPAP, AHI = Apnea-hyponea index, PSG = 16 channel polysomnogram).

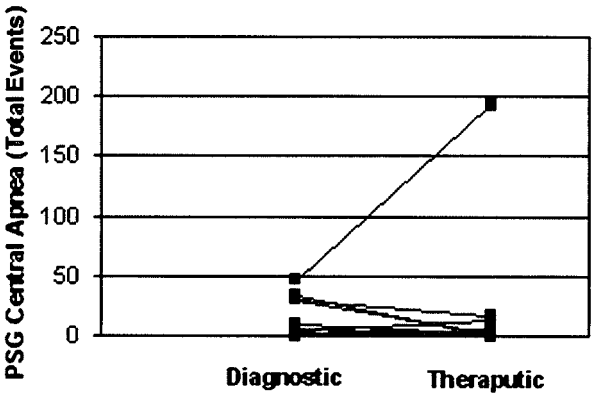

Fig 3. Central apnea data from pretreatment and post-treatment polysomongraphy (PSG) are shown (AHI = apnea hypopnea index)

One concern with unattended APAP is that acute ventilatory changes may occur with the initiation of CPAP. These ventilatory changes may warrant technician intervention. Ventilatory events may include central apneas and rapid eye movement sleep-related hypoventilation and desaturation. These events are rare in the traditional OSAS patient. Furthermore, even in higher-risk patients, it is unclear how to justify such concerns given that CPAP currently is normally initiated in nonattended environments. Patients routinely stop and restart use at home. Patients are often intermittently noncompliant due to transient illnesses, travel, or other causes. Moreover, after a laboratory study, patients routinely wait weeks to reinitiate therapy at home without technicians in attendance. Also, there is no evidence that every cessation of CPAP use requires an attended reinitiation of therapy.

Nasal APAP titration in this study correctly identified residual apnea equivalent to the use of PSG. This correct identification allows the physician to accurately access the efficacy of treatment. No study was aborted due to mask leak, intolerance, or other technical issues. Avoidance of technical flaws in this study may reflect the expertise and knowledge of sleep personal. Patients were sent home with electrodes attached and given instructions and training at our office before the PSG. For patients who have never used nasal CPAP, such training may be critical to acclimate patients to these devices. This included patient counseling by physicians before PSG. The presentation of patients to an academic center may have also affected their response to a novel treatment approach. A bias excluding less confident patients who may not have been amenable to home testing is possible. Such selection bias and the lack of a traditional attended CPAP titration as a control do not allow a direct comparison with the current "standard of care." However, in this group, ob-

structive sleep apnea was treated to a level that was acceptable in a sleep laboratory.

Previous randomized studies have demonstrated the effectiveness of APAP in reducing RDI and improving clinical outcomes.[5,15] These studies are often performed in experienced laboratories and research settings. The current study evaluates the "exportability" of studies to a clinical practice. Although this study supports APAP use in a nonattended environment, it is not an argument against laboratory titration. Split-night titration is still a standard of care in patients who meet diagnostic criteria. In patients with known central apneas or congestive heart failure or those opposed to novel treatment approaches, attended laboratory CPAP titration should be performed. APAP titration, however, may provide an increased access to diagnosis and treatment of OSAS without being restrained by the availability of traditional sleep laboratories. Availability and effectiveness of single-night titration of positive pressure are not the final determinates of treatment efficacy. A single night of therapy does not cure the disease. The potential use of these devices will be determined by whether they improve long-term acceptance of and compliance with positive pressure therapy.

CONCLUSION

APAP is a useful and accurate tool that successfully titrates nasal CPAP pressures in a nonattended setting.

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