

Titration de la pression positive continue: manuelle ou par auto CPAP?

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Formation continue de Pneumologie aux HUG

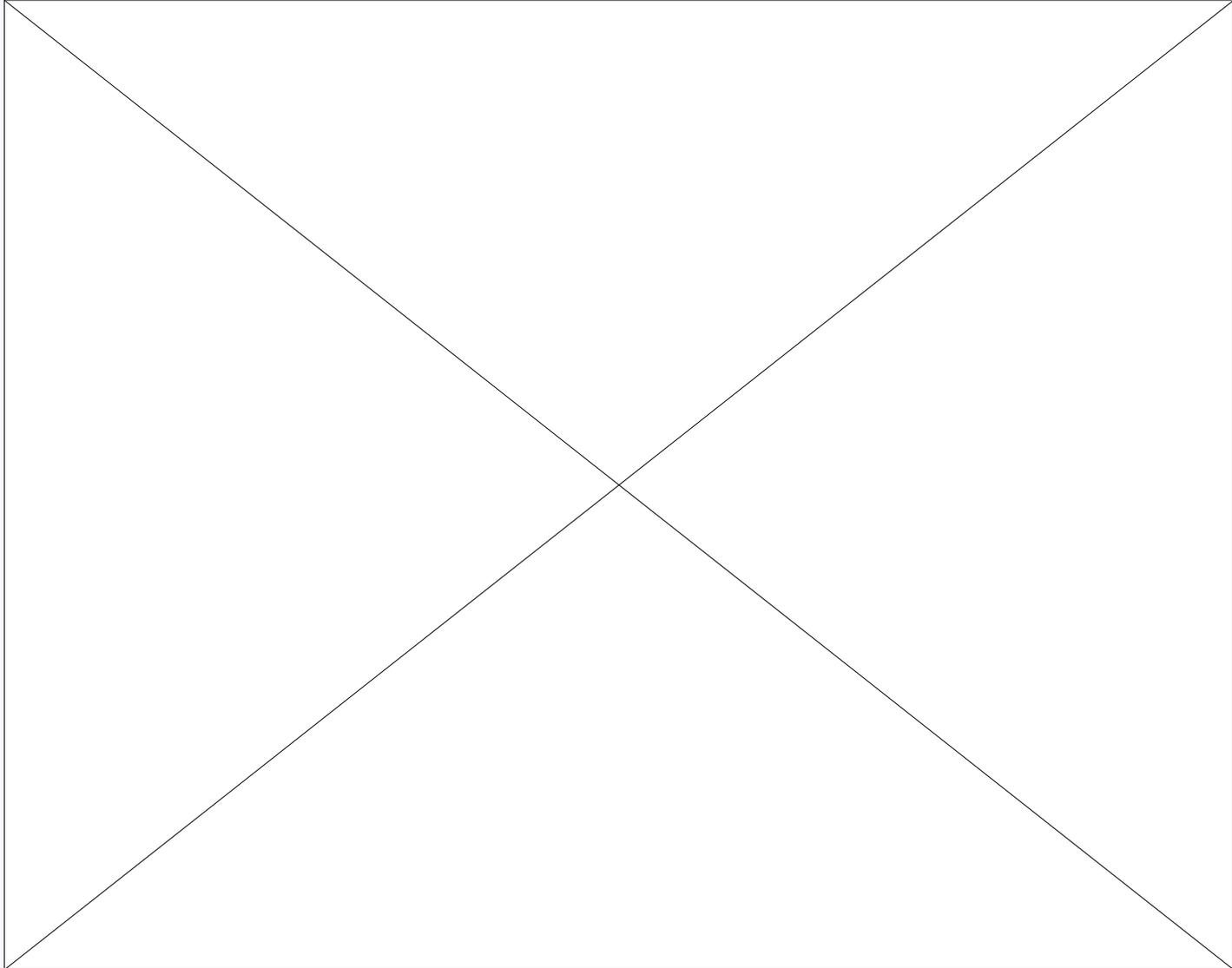


Continuous positive airway pressure for sleep breathing disorders

(Grunstein R and Sullivan C, Principles and Practice of Sleep Medicine, 3rd)

- ✘ Nasal CPAP therapy for sleep apnea was first described in Sydney in 1981 (Sullivan CE, Lancet 1981, 862-865)
- ✘ Nasal CPAP is now the established treatment for sleep apnea-hypopnea syndrome
- ✘ CPAP acts as a pneumatic splint to prevent collapse of the pharyngeal airway, that is, elevating the pressure in the oropharyngeal airway and reversing the transmural pressure gradient across the pharyngeal airway

Breathing During Sleep



CPA...Pressure

- ✘ The optimal pressure selected for an OSA patient is subject to **interindividual variability**
- ✘ There are several **factors** that have been identified as potentially influencing optimal pressure:
 - ✘ The apnea-hypopnea index (**AHI**) *Nino-Murcia G West J Med 1989;150:165-9*
 - ✘ **Obesity**, *Miljeteig H, Am Rev Respir Dis 1993;147(6 Pt 1):1526-30*
 - ✘ The **AHI** has been observed **only** in patients whose apneas are dependent on **body position**. *Pevernagie DA, Sleep 1992;15:162-7*
 - ✘ The **REM** sleep amounts, *Sullivan CE Bull Eur Physiopathol Respir 1984;20:49-54*
 - ✘ **Length of the soft palate**, *Sforza E et al Am J Respir Crit Care Med 1995;151:1852-6*
 - ✘ The degree of **respiratory effort**. *Sforza E et al Am J Respir Crit Care Med 1995;151:1852-6*
- ✘ **i.e.**, a pressure that controls the respiratory events of one patient may inadequately control those of another patient
>> need for **titration**

Titration

- ✘ A **central element** of the CPAP prescription is the pressure level, which is typically derived through a titration study
- ✘ While **obstructive breathing events** will reappear when the **pressure is reduced** below a critical lower limit, **raising the pressure** above an upper threshold will induce air leakage and bring on unwarranted side effects
- ✘ A **successful titration** is one in which there is an optimized trade-off between **increasing pressure** to yield efficacy in elimination of respiratory events and **decreasing pressure** to minimize emergence of pressure-related side effects.

Berthon-Jones M, Lawrence S, Sullivan CE, Grunstein R. Nasal continuous positive airway pressure treatment: current realities and future. *Sleep* 1996;19(9 Suppl):S131-5.

Optimal continuous positive airway pressure for the treatment of obstructive sleep apnea/hypopnea

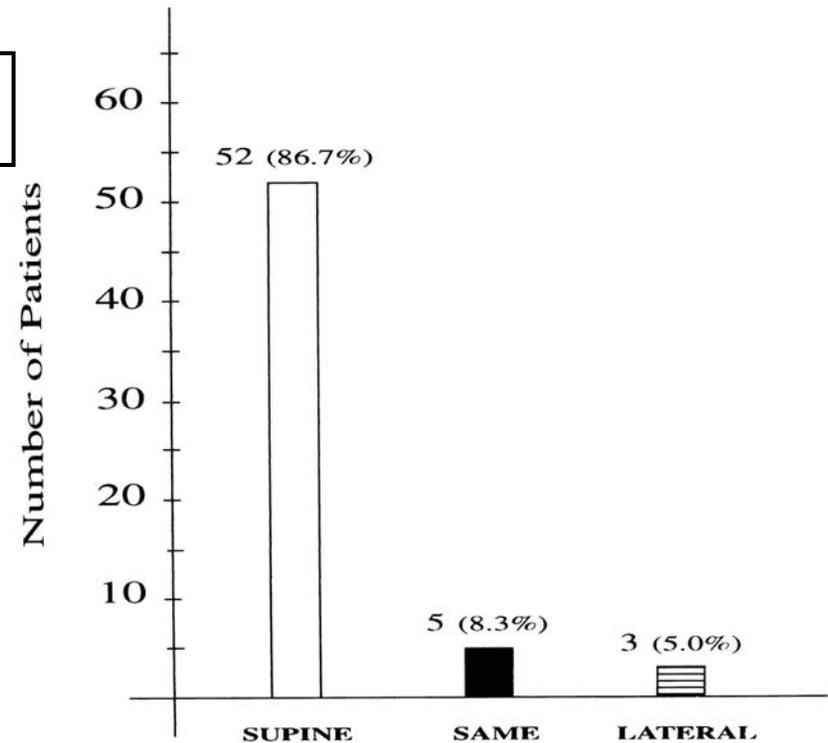
William Beninati¹ and Mark H. Sanders²

Sleep Medicine Reviews, Vol. 5, No. 1, pp 7-23, 2001

- ✘ The titration goals should include both **physiological** and **clinical** parameters
- ✘ The **physiological** goals can be assessed at the time of CPAP titration and will allow to predict how a given level of CPAP will be at eliminating target consequences
- ✘ Level is adjusted to eliminate obstructive respiratory-related events
 - ✘ Apneas, hypopneas, respiratory effort-related arousals [RERAs], and snoring
- ✘ **Clinical** goals are required because physiological parameters may not be totally predictive of clinical success
- ✘ CPAP pressure can be titrated to find a level that is likely to provide successful long-term therapy

- ✘ Finding the lowest pressure that **normalises** respiratory and sleep physiology
1. The extent to which **poor adherence** and side-effects are related to **excessive pressure** is controversial
 2. The required **pressure level** changes with both **body position and stage of sleep**, with the highest pressure levels occurring during stage REM in the supine position Oksenberg A et al *Chest* 1999;116:1000-6
 3. The **pressure level** that is required at the time CPAP **decreases** with continued use of nasal CPAP *Seriès F Eur Resp J* 1994: 1776-1781
 4. « **Sub-therapeutic** » pressures have good clinical **outcomes** *Loredo J Chest* 1999: 1545-1549

The effect of body posture on op-nCPAP



The sequence from highest to lowest op-nCPAP values was as follows:

Supine REM > Supine NREM > Lateral REM > Lateral NREM

Required levels of nasal continuous positive airway pressure during treatment of obstructive sleep apnoea

F. Sériès, I. Marc, Y. Cormier, J. La Forge

Eur Respir J, 1994, 7, 1776-1781

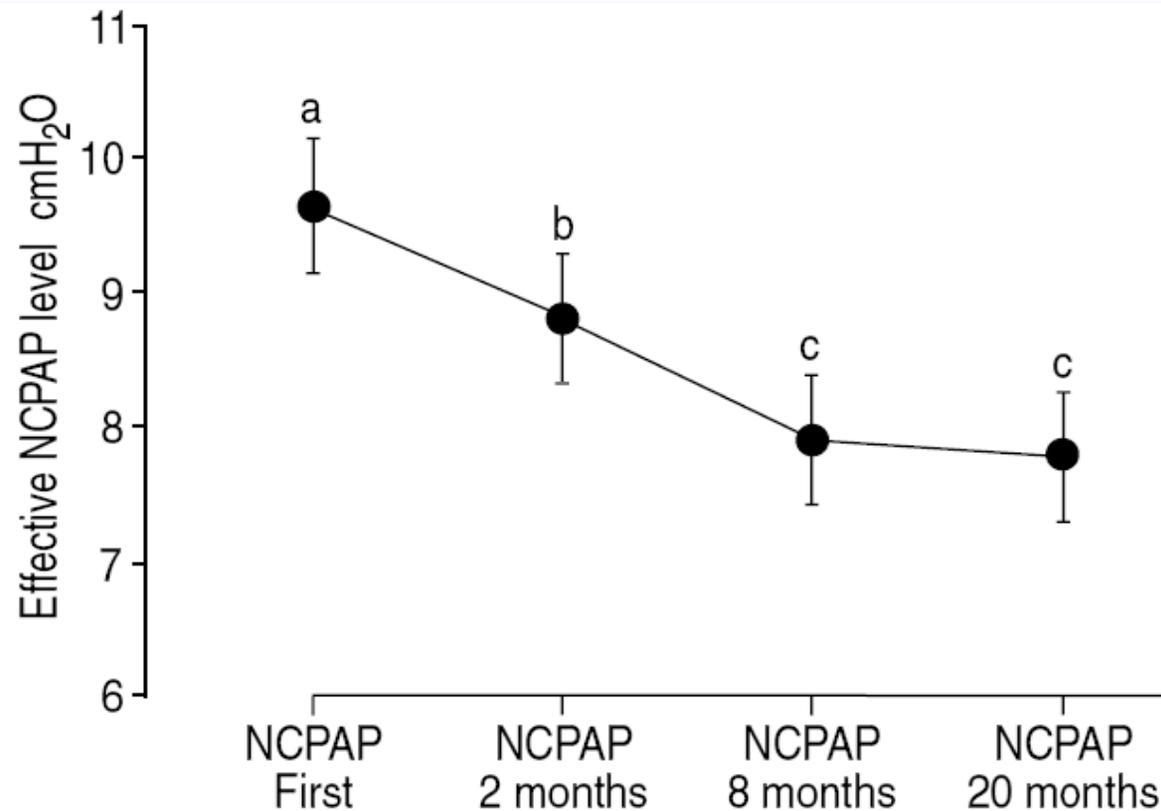


Fig. 1. – Mean \pm SEM values of the effective nasal continuous positive airway pressure (NCPAP) level measured at the different visits. This pressure level progressively decreased with time, the difference being significant after 2 and 8 months of NCPAP therapy. Values with different letters are significantly different from one another. Mean \pm SEM. Note that the vertical axis is magnified and cut-off from zero.

Effect of Continuous Positive Airway Pressure vs Placebo Continuous Positive Airway Pressure on Sleep Quality in Obstructive Sleep Apnea*

José S. Loredó, Sonia Ancoli-Israel and Joel E. Dimsdale

Results: CPAP and placebo CPAP had comparable effects on sleep quality as assessed by sleep architecture, sleep efficiency, total sleep time, and wake after sleep onset time.

While essentially no data on the hypothetical upper pressure limit exist, it is known from the literature that "sham" nasal CPAP levels as low as 2 cm H₂O may induce significant improvements in markers of sleep-disordered breathing

Table 2—Sleep Quality at Baseline and After Treatment*

Variable	Sleep Quality		
	Baseline	After 1 Day	After 7 Days
Sleep latency, min			
CPAP	9.4 ± 10.0	8.0 ± 6.0	5.3 ± 6.2
Placebo	10.8 ± 12.6	3.8 ± 3.8	5.1 ± 4.9
Stage 1 sleep, %			
CPAP	23.3 ± 24.2	9.8 ± 7.3	9.8 ± 9.3
Placebo	21.9 ± 20.2	13.4 ± 16.0	15.4 ± 17.3
SWS, %			
CPAP	7.4 ± 8.7	16.1 ± 12.2	12.8 ± 10.6
Placebo	6.3 ± 8.6	10.6 ± 10.0	13.0 ± 14.5
REM sleep, %			
CPAP	19.0 ± 7.9	25.8 ± 7.8	26.2 ± 7.0
Placebo	17.7 ± 8.0	22.3 ± 10.2	19.2 ± 8.3
WASO, min			
CPAP	42.6 ± 33.6	26.0 ± 22.9	32.0 ± 18.2
Placebo	49.2 ± 32.7	26.9 ± 26.2	43.0 ± 41.1
TST, min			
CPAP	319.9 ± 20.5	336.2 ± 20.8	334.0 ± 42.6
Placebo	317.1 ± 46.1	318.6 ± 60.4	307.4 ± 83.0
Sleep efficiency, %			
CPAP	83.7 ± 10.7	88.3 ± 9.4	88.1 ± 8.6
Placebo	82.2 ± 11.8	87.9 ± 6.1	83.7 ± 12.9
Sao ₂ †			
CPAP	89.1 ± 6.6	95.4 ± 1.4	95.6 ± 1.3
Placebo	93.8 ± 1.7	93.9 ± 2.6	94.1 ± 2.1
Total arousal index†			
CPAP	88.1 ± 24.4	11.6 ± 5.5	14.4 ± 9.8
Placebo	48.6 ± 28.2	33.3 ± 21.2	33.8 ± 23.2
RDI†			
CPAP	26.4 ± 24.1	5.1 ± 5.6	3.3 ± 3.8
Placebo	44.2 ± 25.3	26.1 ± 19.5	28.3 ± 22.7

*Values given as mean ± SD.

†Significant CPAP × time interaction (p = 0.001).

CPAP titration studies



Manual titration

BACKGROUNd

- ✘ **Manual titration** of CPAP/BPAP is the **gold standard** for selection of the optimal pressure
- ✘ The manual titration has been conducted for over a quarter of a century *Juhasz J Sleep Breath 2007;11:65-7*
- ✘ Pressure adjustment by a sleep technologist step by step on a “trial-error basis” during attended laboratory polysomnography to eliminate:
 - ✘ **Obstructive respiratory-related events** (apneas, hypopneas, respiratory effort-related arousals [RERAs], and snoring)
- ✘ In addition, titration under attended polysomnography allows for **interventions** to adjust mask fit, eliminate leak, and help the patient adapt to the initial CPAP experience

✘ 4.1.3.2 Polysomnography is indicated for **CPAP titration** in patients with sleep related breathing disorders (**Standard**)

- 1) A **full night of PSG** with CPAP titration is recommended for patients with a documented diagnosis of a SRBD for whom PAP is warranted
- 2) PSG with CPAP titration is appropriate for patients with any of the following results:
 - a) An RDI of at least 15 per hour, regardless of the patient's symptoms
 - b) An RDI of at least 5 per hour in a patient with excessive daytime sleepiness

Practice Parameters for the Use of Continuous and Bilevel Positive Airway Pressure Devices to Treat Adult Patients With Sleep-Related Breathing Disorders

An American Academy of Sleep Medicine Report

SLEEP 2006;29(3):375-380

- ✘ 4.2.1 Full-night, attended polysomnography performed in the laboratory is the preferred approach for titration to determine optimal positive airway pressure (*Guideline*)

- ✘ Pressure adjustment during attended laboratory polysomnography to eliminate *obstructive respiratory-related events*

- ✘ Apneas, hypopneas, oxygen desaturations, snoring, respiratory effort related arousals [RERAs]

✘ Yet no **standardized protocols** exist for this procedure *Stepanski EJ J Clin Sleep Med 2005;1:311*

- ✘ In a survey from 51 accredited centers the procedures described for PAP titration varied widely among the centers
- ✘ 22% of these centers did not have a written protocol

✘ The lack of standardization results in clinicians and technologists from different sleep laboratories developing their own protocols or relying on protocols obtained from industry or other sleep laboratories

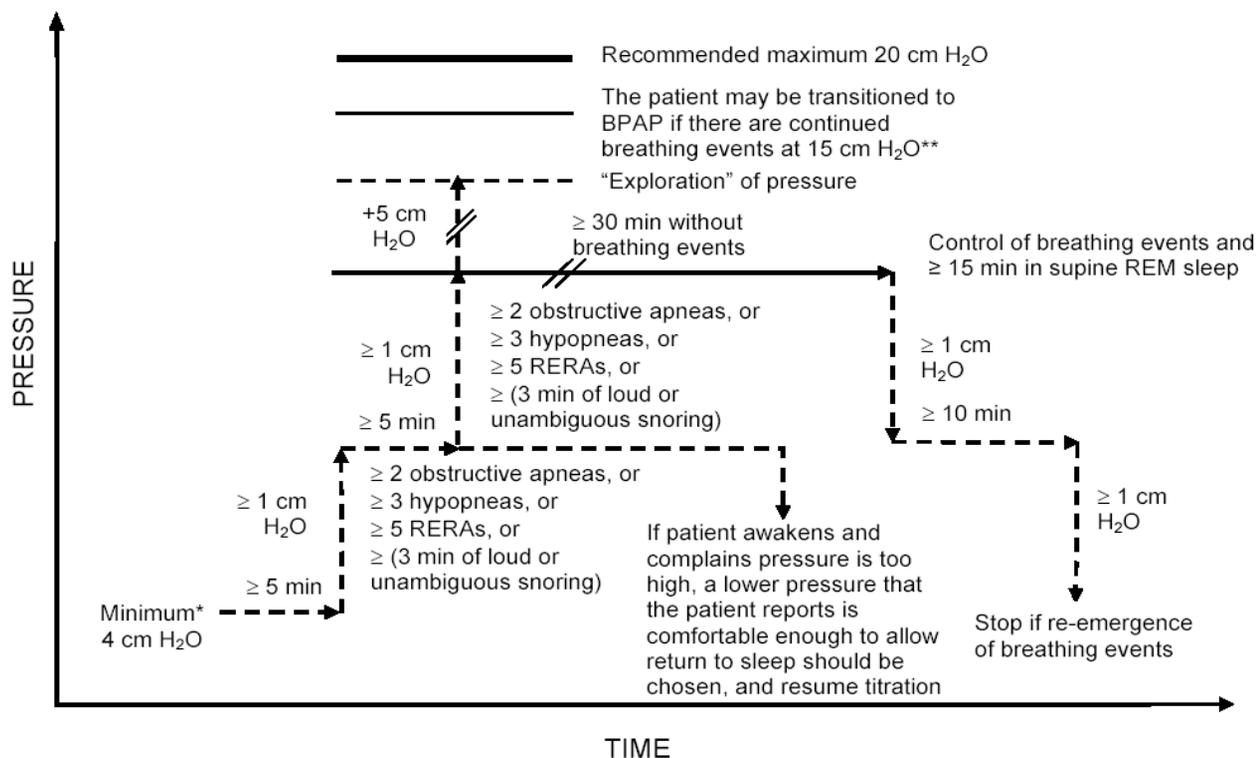
✘ When a standardized protocol is implemented, the optimal pressure for CPAP can be reproducible

SPECIAL ARTICLE

Clinical Guidelines for the Manual Titration of Positive Airway Pressure in Patients with Obstructive Sleep Apnea

Positive Airway Pressure Titration Task Force of the American Academy of Sleep Medicine

CPAP Titration Algorithm for Patients ≥ 12 years



✘ 4.2.2.6 "exploration" of CPAP above the pressure at which control of abnormalities in respiratory parameters is achieved should not exceed 5 cm H₂O (**consensus**)

- ✘ **upper airway resistance** can be abnormal despite selection of a pressure that eliminates apneas and hypopneas *Montserrat JM et al Am J Respir Crit Care Med 1995;152:1854-9*
- ✘ and this residual high airway resistance can lead to **repetitive arousals** and insomnia *Guilleminault C et al Chest 1993;104:781-7*
- ✘ Reduction of this resistance has been demonstrated by increasing pressure until **esophageal pressure** swings (if measured) or **the shape of the inspiratory flow** limitation curve are normalized *Condos R et al Am J Respir Crit Care Med 1994;150:475-8*
- ✘ or by increasing pressure by 2 cm H₂O but no higher than by 5 cm H₂O *Berthon-Jones et al Sleep 1996;19(9 Suppl):S131-5*

✘ 4.2.2.8 "Down" titration is not required but may be considered as an option (**consensus**).

✘ A "down" titration is recommended due to the "**hysteresis**" phenomenon: during upward titration the PAP level at which flow limitation disappears is **2-5 cm H₂O** higher than the level at which it reappears during downward titration *Condos R et al Am J Respir Crit Care Med 1994;150:475-8*

✘ 4.4.1.2 Grading system (consensus):

- ✘ An **optimal titration** reduces RDI < 5 per hour for at least a 15-min duration and should include supine REM sleep at the selected pressure that is not continually interrupted by spontaneous arousals or awakenings
- ✘ A **good titration** reduces the overnight RDI ≤ 10 per hour or by 50% if the baseline RDI < 15 per hour and should include supine REM sleep that is not continually interrupted by spontaneous arousals or awakenings at the selected pressure
- ✘ An **adequate titration** is one that does not reduce the overnight RDI ≤ 10 per hour but does reduce the RDI by 75% from baseline (especially in severe OSA patients), or one in which the titration grading criteria for optimal or good are met with the exception that supine REM sleep did not occur at the selected pressure

- ✘ **4.4.4.1** Ideally, the patient should be recorded in **supine REM sleep** for at least 15 min at the designated optimal pressure during the PAP titration study (**consensus**)

- ✘ Optimal CPAP has been defined as the **highest pressure** obtained during **REM** sleep with the patient having slept in the **supine** position. *Lloberes P et al Respir Med 2004;98:619-25*

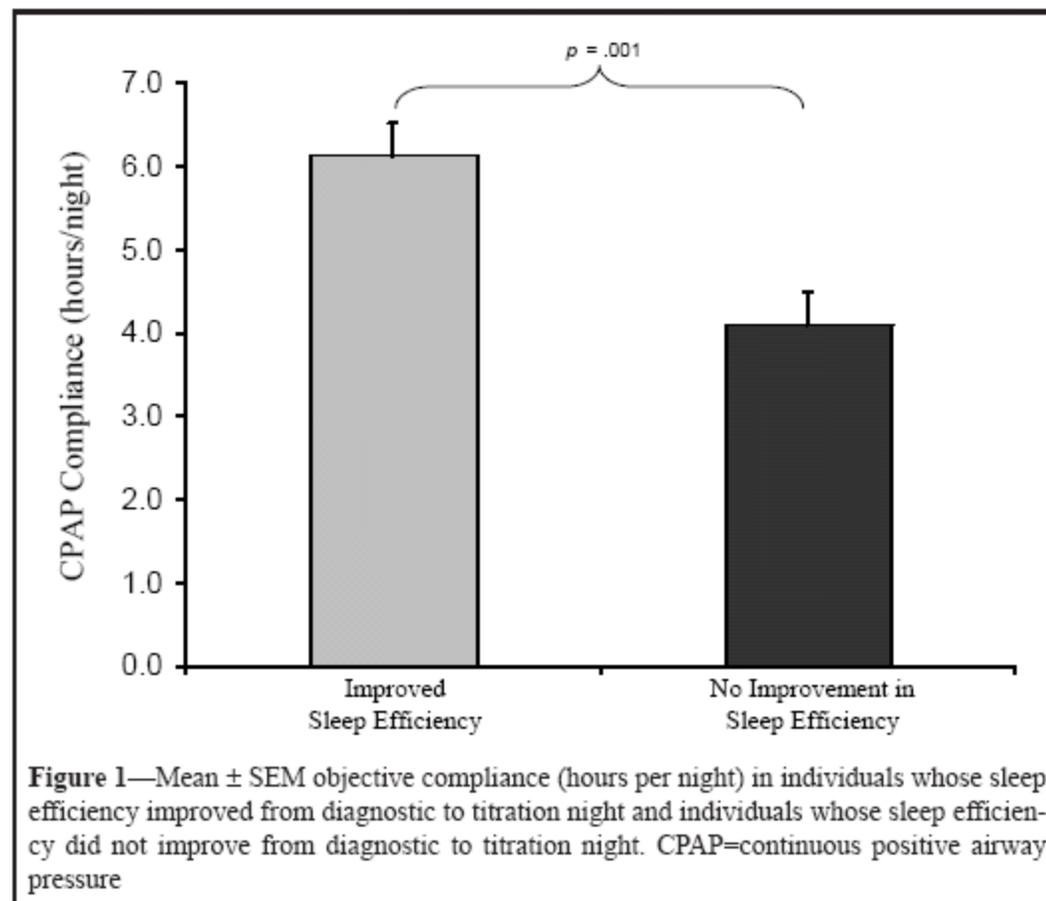
- ✘ Since treatment emergent **central sleep apnea** is more likely to occur in **NREM** sleep, it is also important to evaluate patients at the designated optimal pressure during NREM sleep. *Gilmartin GS et al Curr Opin Pulm Med 2005;11:485-93*

- ✘ There is evidence that the optimal CPAP level in the **supine** position is greater than **2 cm H₂O higher** than the optimal CPAP needed while sleeping in the **lateral** position, both in REM and NREM sleep, in obese and nonobese subjects and in those younger and older than 60 years. *Oksenberg A et al Chest 1999;116:1000-6*

Sleep During Titration Predicts Continuous Positive Airway Pressure Compliance

Christopher L. Drake, PhD; Ryan Day, BS; David Hudgel, MD; Yevgeniy Stefadu, MD; Mary Parks, LPN; Mary Lou Syron; Thomas Roth, PhD

SLEEP 2003;26(3):308-11.



Limitations

- ✘ It is labour intensive, time consuming, and expensive
- ✘ This procedure only provides useful information on the P_{eff} level during one single night in a dedicated environment
 - ✘ Sleep conditions during the titration sleep study significantly differ from those encountered at home
 - ✘ Intra-night and night-to-night changes in P_{eff}
 - ✘ REM and supine position
 - ✘ The falling pressure over the first few weeks of treatment
Monton C Arch Bronconeumol 1994;30:385-9
 - ✘ Variation in pressure due to changes in nasal resistance, alcohol consumption, drugs and sleep deprivation

-
- ✘ The **high prevalence** of OSA and the demonstrated **benefit of CPAP** suggest that a substantial portion of the population might benefit from CPAP titration and therapy
 - ✘ For this to be practical the **cost** of CPAP titration needs to be **decreased** and the **availability** increased
 - ✘ A number of **alternative approaches** have been developed

Practice Parameters for the Indications for Polysomnography and Related Procedures: An Update for 2005

SLEEP 2005;28(4):499-521

- ✘ 4) For CPAP titration, a **split-night study** (initial diagnostic PSG followed by CPAP titration during PSG on the same night) is an alternative to one full night of diagnostic PSG followed by a second night of titration if the following four **criteria** are met (**Standard**)
 - ✘ a) An **AHI** of at least 40 is documented during a minimum of **2 hours** of diagnostic PSG. Split-night studies may sometimes be considered at an AHI of 20 to 40, based on clinical judgment (e.g., if there are also repetitive long obstructions and major desaturations). However, at AHI values below 40, determination of CPAP pressure requirements, based on split-night studies, may be less accurate than in full-night calibrations.
 - ✘ b) **CPAP titration** is carried out for more than **3 hours** (because respiratory events can worsen as the night progresses)
 - ✘ c) PSG documents that CPAP eliminates or nearly eliminates the respiratory events during REM and non-REM sleep, including **REM sleep** with the patient in the **supine position**
 - ✘ d) A second full night of PSG for CPAP titration is performed if the diagnosis of a SRBD is confirmed but criteria b and c are not met

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SLEEP 2006;29(3):375-

380

✘ **4.2.1** Full-night, attended polysomnography performed in the laboratory is the preferred approach for titration to determine optimal positive airway pressure; however, **split-night**, diagnostic-titration studies are usually **adequate** (Guideline)

- ✘ Fleury B, Rakotonanahary D, Tehindrazanarivelo AD, Hausser- Hauw C, Lebeau B. Long-term compliance to continuous positive airway pressure therapy (nCPAP) set up during a split-night polysomnography. *Sleep*. Sep 1994;17(6):512-515.
- ✘ Jokic R, Klimaszewski A, Sridhar G, Fitzpatrick MF. Continuous positive airway pressure requirement during the first month of treatment in patients with severe obstructive sleep apnea. *Chest*. Oct 1998;114(4):1061-1069. 1367.
- ✘ McArdle N, Grove A, Devereux G, Mackay-Brown L, Mackay T, Douglas NJ. Split-night versus full-night studies for sleep apnoea/ hypopnoea syndrome. *Eur Respir J*. Apr 2000;15(4):670-675.
- ✘ Sanders MH, Costantino JP, Strollo PJ, Studnicki K, Atwood CW. The impact of split-night polysomnography for diagnosis and positive pressure therapy titration on treatment acceptance and adherence in sleep apnea/hypopnea. *Sleep*. Feb 1 2000;23(1):17-24.
- ✘ Sanders MH, Kern NB, Costantino JP, et al. Adequacy of prescribing positive airway pressure therapy by mask for sleep apnea on the basis of a partial-night trial. *Am Rev Respir Dis*. May 1993;147(5):1169-1174.
- ✘ Strollo PJ, Jr., Sanders MH, Costantino JP, Walsh SK, Stiller RA, Atwood CW, Jr. Split-night studies for the diagnosis and treatment of sleep-disordered breathing. *Sleep*. Dec 1996;19(10 Suppl):S255- 259.
- ✘ Yamashiro Y, Kryger MH. CPAP titration for sleep apnea using a split-night protocol. *Chest*. Jan 1995;107(1):62-66.

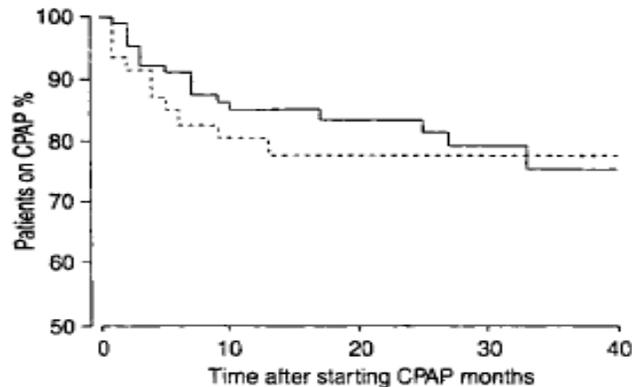


Figure 4 Long-term CPAP use: split-night (---, $n = 46$) versus full-night (—, $n = 92$). No difference between the groups was present with respect to the percentage of patients in continued CPAP use. From McArdle N, Grove A, Devereux G, Mackay-Brown L, Mackay T, Douglas NJ. Split-night versus full-night studies for sleep apnoea/hypopnoea syndrome. *European Respiratory Journal* 2000; 15: 670–675. Reprinted with permission.

✘ A substantial proportion of patients (45%) still required a subsequent change in prescribed

nCPAP pressure

Sanders M, Kern N, Costantino J, et al. Adequacy of prescribing positive airway pressure therapy by mask for sleep apnea on the basis of a partial-night trial. *Am Rev Respir Dis* 1993; 147: 1169-1174.

Daytime CPAP Titration*

A Viable Alternative for Patients With Severe Obstructive Sleep Apnea

Leon Rosenthal, MD; Keith Nykamp, BA; Peter Guido, MD; Mary Lou Syron, BA; Ryan Day, BS; F. Matthew Rice, BA; and Thomas Roth, PhD

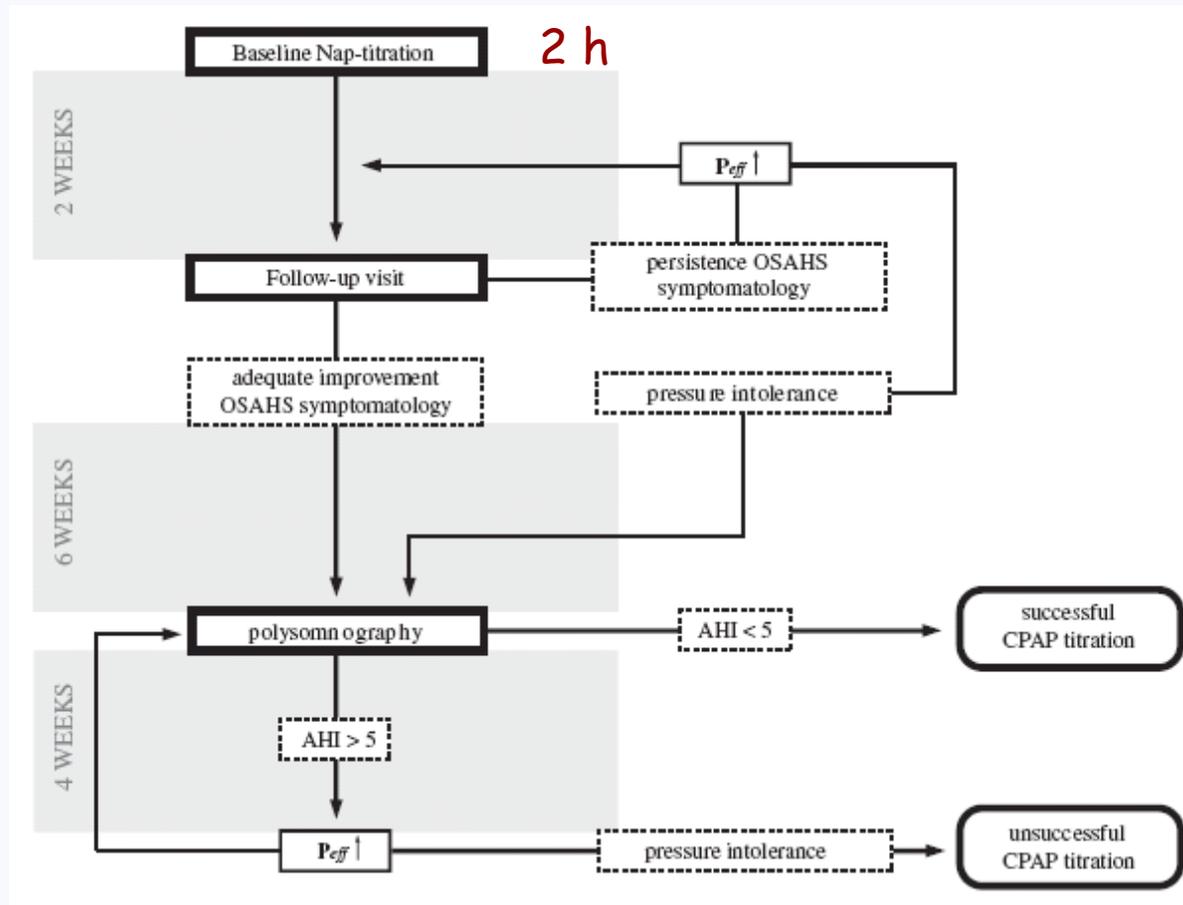
Study design: Fourteen patients (13 men and one woman) received a daytime CPAP titration (day group). The day group was matched to 18 patients (17 men and one woman) who were titrated under a full-night regular nocturnal study (night group). Eligible patients were those with severe OSA (respiratory event index > 40). The groups were matched by age, sex, and body mass index.

Results: Daytime and nocturnal CPAP titration studies yielded sufficient amounts of rapid eye movement (REM) and non-REM sleep to help determine CPAP settings. Importantly, the diurnal and nocturnal CPAP titrations resulted in comparable therapeutic pressures as well as comparable resolution of sleep-disordered breathing. After 1 week of treatment, the groups exhibited similar CPAP use and comparable improvements in subjective sleepiness as indicated by their increase in sleep/wake activity inventory scores.

Conclusions: Daytime CPAP titration studies may be a viable alternative for the efficient and expedient implementation of CPAP therapy among some patients with severe OSA.

Nap-titration: An effective alternative for continuous positive airway pressure titration

Aarnoud Hoekema^{a,*}, Boudewijn Stegenga^a, Johannes G. van der Aa^b,
Aafke F. Meinesz^{b,c}, Johannes H. van der Hoeven^d, Peter J. Wijkstra^{b,c}

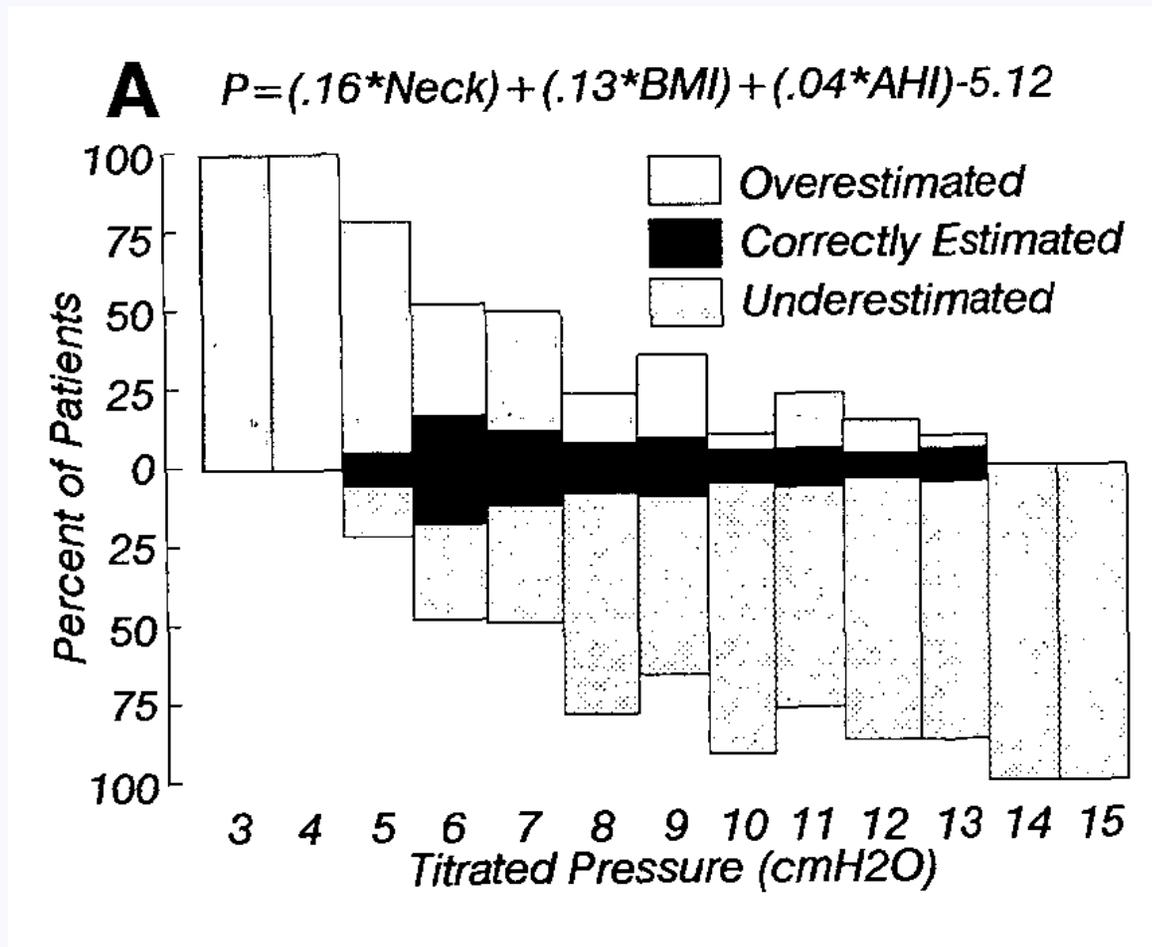


Successful CPAP titration in 96% of OSAHS patients'

Clinical prediction

- ✘ **Mathematical equations** incorporating measures of OSA severity (AHI) and obesity (i.e., body mass index and neck circumference) have been developed to predict the optimal level of CPAP Miljeteig H, Am Rev Respir Dis 1993;147:1526-30 ; Hoheisel GB, Am J Resp Crit Care Med 1994;149:A496; Hoffstein V, Am J Respir Crit Care Med 1994;150:486-8
- ✘ However, studies have independently **failed to confirm** the accuracy of these equations in predicting the prescribed CPAP level Rowley JA, Sleep Breath 2005;9:26-32. Gokcebay N, Sleep 1996;19:600-1. Gokcebay N, Sleep. 1997;20:237-8.

Accuracy of CPAP Predicted From Anthropometric and Polysomnographic Indices



Formula was accurate for 14% of patients

Auto-CPAP

Autoadjusting Continuous Positive Airway Pressure

What Can We Expect?

PATRICK LÉVY AND JEAN-LOUIS PÉPIN

AMERICAN JOURNAL OF RESPIRATORY AND CRITICAL CARE MEDICINE VOL 163 2001

- ✘ Since 1996, there have been technologies that allow automatic adjustment of CPAP
- ✘ Dynamically change the airway pressure based on the individual requirements of the patients within a single night or during a longer period of time
- ✘ APAP to perform titration: Auto-titrating devices can be used to determine an optimal fixed pressure level for long term treatment with a conventional CPAP device
 - ✘ In the ward
 - ✘ At home, used for 1 or 2 wk at home

-
- ✘ A number of auto-titrating PAP devices are commercially available
 - ✘ What is monitored (snoring, apnea, hypopnea, airflow limitation, impedance) and the algorithms for changing pressures vary between devices
 - ✘ In general, pressure increases to maintain airway patency and then decreases if no events are detected over a set period of time
 - ✘ APAP units store pressure vs. time data and many can record mask leak, apnea events, and hypopnea occurrences
 - ✘ When transferred to a computer, this information provides both detailed and summary night by night results
 - ✘ The clinician can use these results to select a fixed pressure for subsequent CPAP treatment
 - ✘ They inevitably "hunt" around the ideal pressure and may respond inappropriately on some occasions, they could result in a more disturbed first night on CPAP and reduce the patient's enthusiasm to try the treatment at home

Practice Parameters for the Use of Auto-Titrating Continuous Positive Airway Pressure Devices for Titrating Pressures and Treating Adult Patients with Obstructive Sleep Apnea Syndrome

An American Academy of Sleep Medicine Report

SLEEP, Vol. 25, No. 2, 2002

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

6. Use of **unattended** APAP to either initially determine pressures for fixed CPAP or for self-adjusting APAP treatment in CPAP-naïve patients is **not** currently established (**Option**)

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

SLEEP 2008;31:141-147

✘ 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)

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

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

SLEEP 2008;31:141-147

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**)

- ✘ **Sleep** information
- ✘ Allow a technician to attend titration of more patients
- ✘ Allow **interventions** for problems with mask fit, mask leaks
- ✘ As in technician-directed PAP titrations, a careful review of the whole PSG is recommended to determine the optimal pressure
- ✘ Only one night: provides information on the *P_{eff}* level during **one single night** in a dedicated **environment**

Automatic nasal continuous positive airway pressure titration in the laboratory: patient outcomes

Thorax An International Journal of Respiratory Medicine

J R Stradling, C Barbour, D J Pitson, R J Odavies

Thorax 1997;52:72-75

Horizon®, DeVilbiss

- ✘ NCPAP pressures were similar (manual 8.7 (2.5) cm H₂O, automatic 8.2 (2.1) cm H₂O)
- ✘ The percentage of patients successfully established on CPAP at six weeks was 64% and 73% for the manual and automatic groups
- ✘ 13% and 2%, respectively, in the manual and automatic groups had given up completely (p<0.05)

Conclusions - The substitution of automatic NCPAP titration for manual titration during the first night of NCPAP in patients with OSA does not reduce the number accepting the treatment at six weeks and may slightly improve it. This has important cost saving potential.

Alternative Methods of Titrating Continuous Positive Airway Pressure

A Large Multicenter Study

Am J Respir Crit Care Med Vol 170. pp 1218–1224, 2004

Juan F. Masa, Antonio Jiménez, Joaquín Durán, Francisco Capote, Carmen Monasterio, Mercedes Mayos, Joaquín Terán, Lourdes Hernández, Ferrán Barbé, Andrés Maimó, Manuela Rubio, and José M. Montserrat

- ✘ **Manual** titration vs in lab auto-titration (**Autoset-T®**, ResMed) vs **formula** with domiciliary adjustment partnert report
($P = (0.16 \times \text{BMI}) + (0.13 \times \text{neck circ}) + (0.04 \times \text{AHI}^\circ - 5.12)$)
- ✘ Follow up **12 weeks: polysomnography**
- ✘ **AHI, ESS, QOL, compliance =**

Automatic Pressure Titration with APAP Is as Effective as Manual Titration with CPAP in Patients with Obstructive Sleep Apnea

Ingo Fietze^a Martin Glos^a Isabel Moebus^a Christian Witt^b Thomas Penzel^a
Gert Baumann^c

REMstar® Auto (Respironics)

- ✘ Attended automatic titration vs manual
- ✘ 2 random nights
- ✘ Outcome at 6 weeks
- ✘ Compliance and ESS =
- ✘ Sleep better the first night with Auto-CPAP

Comparison of manual titration and automatic titration based on forced oscillation technique, flow and snoring in obstructive sleep apnea

Wolfgang Galetke^{a,*}, Winfried J. Randerath^a, Sven Stieglitz^a, Cordula Laumanns^a,
Norbert Anduleit^a, Kerstin Richter^a, Thorsten Schäfer^b

SOMNOSet®

- ✘ Participants were randomly assigned to attended in-laboratory manual titration and automatic titration in two consecutive nights
- ✘ The follow-up period was **six weeks**.
- ✘ **AHI** and **ESS** showed a similar improvement
- ✘ Careful evaluation of raw data and polysomnography recording is mandatory before choosing a fixed CPAP pressure after automatic titration

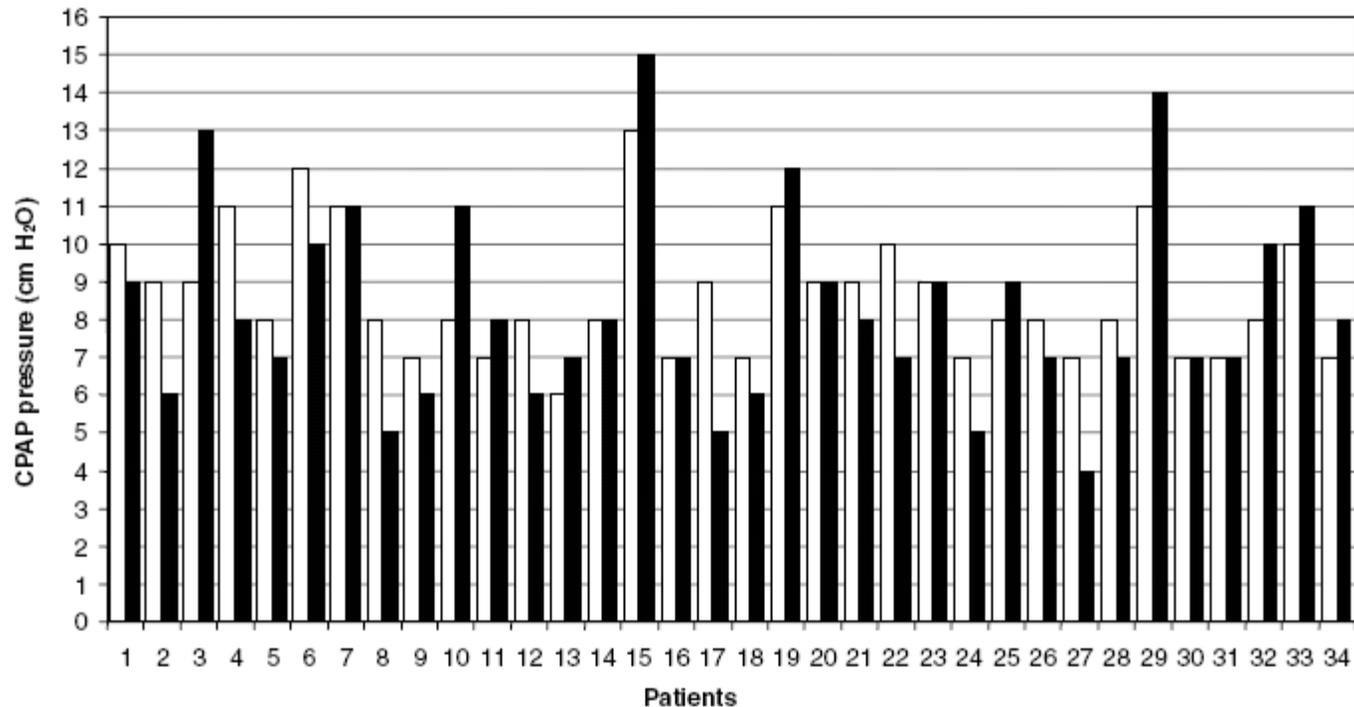


Fig. 1. Optimal CPAP pressure determined by the technician in the manual titration night (grey column) and in the automatic titration night after analysing the raw data of the device (black column).

Pressure recommendation by the device and the technician, although not statistically different (8.7 ± 2.9 vs. 9.0 ± 3.3 mbar), corresponded only in 50% of the patients.

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

SLEEP 2008;31:141-147

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

- ✘ The need for attended laboratory CPAP titration would be reduced, this may extend CPAP availability to a wider patient group, deliver treatment in a more timely manner, and potentially reduce costs
- ✘ CPAP titration conducted at home during several nights
- ✘ Take into account the night-to night variability in the Peff level

✘ NO SLEEP INFORMATION

Accuracy of an Unattended Home CPAP Titration in the Treatment of Obstructive Sleep Apnea

F. SÉRIÈS

Am J Respir Crit Care Med Vol 162. pp 94-97, 2000



- ✘ Determine the adequate setting for fixed CPAP therapy after an **automatic CPAP trial at home** for several days without need of an in-hospital titration sleep study: **1-2 weeks**
- ✘ Sleep improved with fixed CPAP, with a normalization of the AHI in 38 of 40 and resumption of diurnal hypersomnolence
- ✘ CPAP compliance remained excellent (CPAP use: 6.1 6 1.7 h/ night) after 6.5 +/- 2.8 mo of CPAP treatment
- ✘ These results indicate that auto-CPAP therapy represents a new useful and accurate way to identify conventional CPAP setting outside hospital and sleep laboratories

Comparison of CPAP Titration at Home or the Sleep Laboratory in the Sleep Apnea Hypopnea Syndrome

SLEEP 2006:1451-1455

Melanie D. Cross, MRCP¹; Marjorie Vennelle, RGN¹; Heather M. Engleman, PhD¹; Sandra White, BSc¹; Thomas W. Mackay, FRCP¹; Sarah Twaddle, PhD²; Neil J. Douglas, FRCP¹

- ✘ Standard 1-night in-hospital CPAP titration vs **3 nights'** home CPAP titration (**Spirit®**; Res Med, San Diego, Calif) and then issued with fixed pressure CPAP
- ✘ At **3 month follow-up**, there was no significant difference in **CPAP use**, **ESS**, **OSLER** or **SF36** between the sleep-laboratory and home titrated groups

Efficacy and Cost of Home-Initiated Auto-nCPAP versus Conventional nCPAP

Carole Planès MD, PhD;¹ Marie-Pia D'Ortho MD, PhD;^{2,6} Arlette Foucher MD;¹ Malika Berkani MD;³ Karl Leroux;⁴ Mohamed Essalhi MD;⁴ Christophe Delclaux MD, PhD;² Maria-Antonia Quera-Salva MD, PhD;⁵ Frédéric Lofaso MD, PhD^{5,6}

SLEEP 2003;2:156-160

- ✘ Titration at the sleep laboratory vs the REM+ auto® (Respironics) device in automatic mode initiated at the patient's home (1 week)
- ✘ After 2 months, the efficacy and cost of nCPAP therapy and the time from diagnosis to nCPAP were evaluated
- ✘ Similar decreases in the AHI and ESS
- ✘ With auto-nCPAP initiated at home, the time from diagnosis to final adjustment of nCPAP was shorter and the cost was lower

Limitations

✘ Selected patients

- ✘ 3.2. Patients with congestive heart failure, significant lung disease such as chronic obstructive pulmonary disease, patients expected to have nocturnal arterial oxyhemoglobin desaturations due to conditions other than OSA (e.g., obesity-hypoventilation syndrome), patients who don't 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 treatment. (**Standard**) Juhász J, Schillen J, Urbigkeit A, Ploch T, Penzel T, Peter JH (1996) *Am J Respir Crit Care Med* 154:359–365

✘ Titration procedure is not standardized

✘ Precise monitoring of the raw data during polysomnography or collected by the APAP device

✘ Substantial differences in the performance of automatic nCPAP devices in the clinical setting

Response of Automatic Continuous Positive Airway Pressure Devices to Different Sleep Breathing Patterns

A Bench Study

Ramon Farré, Josep M. Montserrat, Jordi Rigau, Xavier Trepast, Paula Pinto, and Daniel Navajas



Vol 166. pp 469–473, 2002

- ✘ The bench study allows the comparison of the responses of different devices when they are subjected to exactly the same patterns of disturbed breathing, which is not possible in patients, given the variability in their disturbed breathing patterns
- ✘ D1: DeVilbiss AutoAdjust LT® (Sunrise Medical, Somerset, PA)
- ✘ D2: Autoset Portable II Plus® (Resmed, North Ryde, Australia)
- ✘ D3: Autoset-T® (Resmed, North Ryde, Australia)
- ✘ D4: Virtuoso LX® (Respironics, Murrysville, PA)
- ✘ D5: Goodknight 418P® (Mallinckrodt, Villers-les-Nancy, France)

Response of Automatic Continuous Positive Airway Pressure Devices to Different Sleep Breathing Patterns

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Vol 166. pp 469–473. 2002

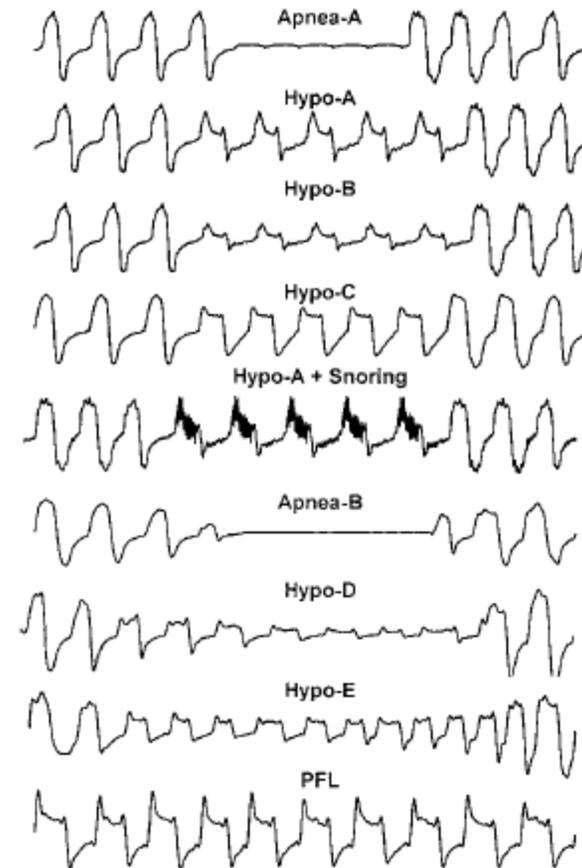
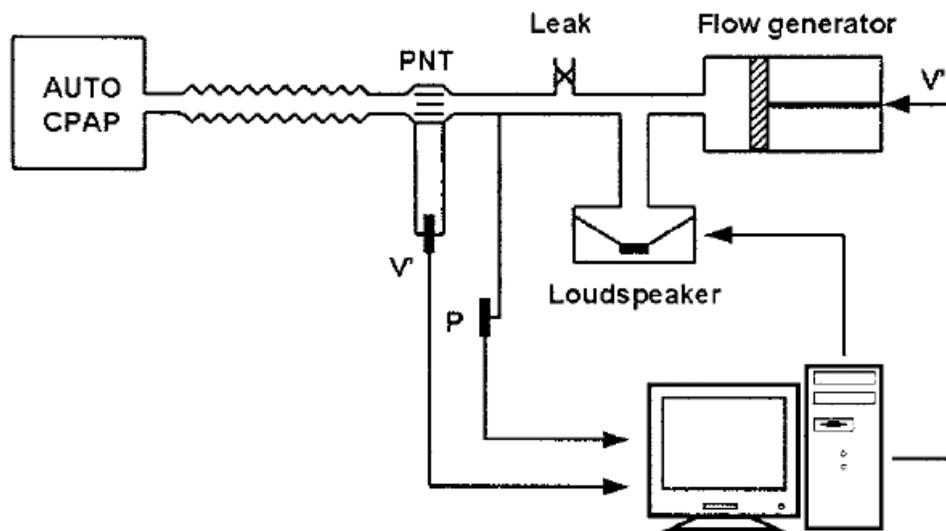


Figure 2. Actual flow events used to generate breathing patterns for testing automatic CPAP devices: different types of apneas, hypopneas (Hypo-A to Hypo-E), snoring, and a persistent pattern of flow limitation (PFL).

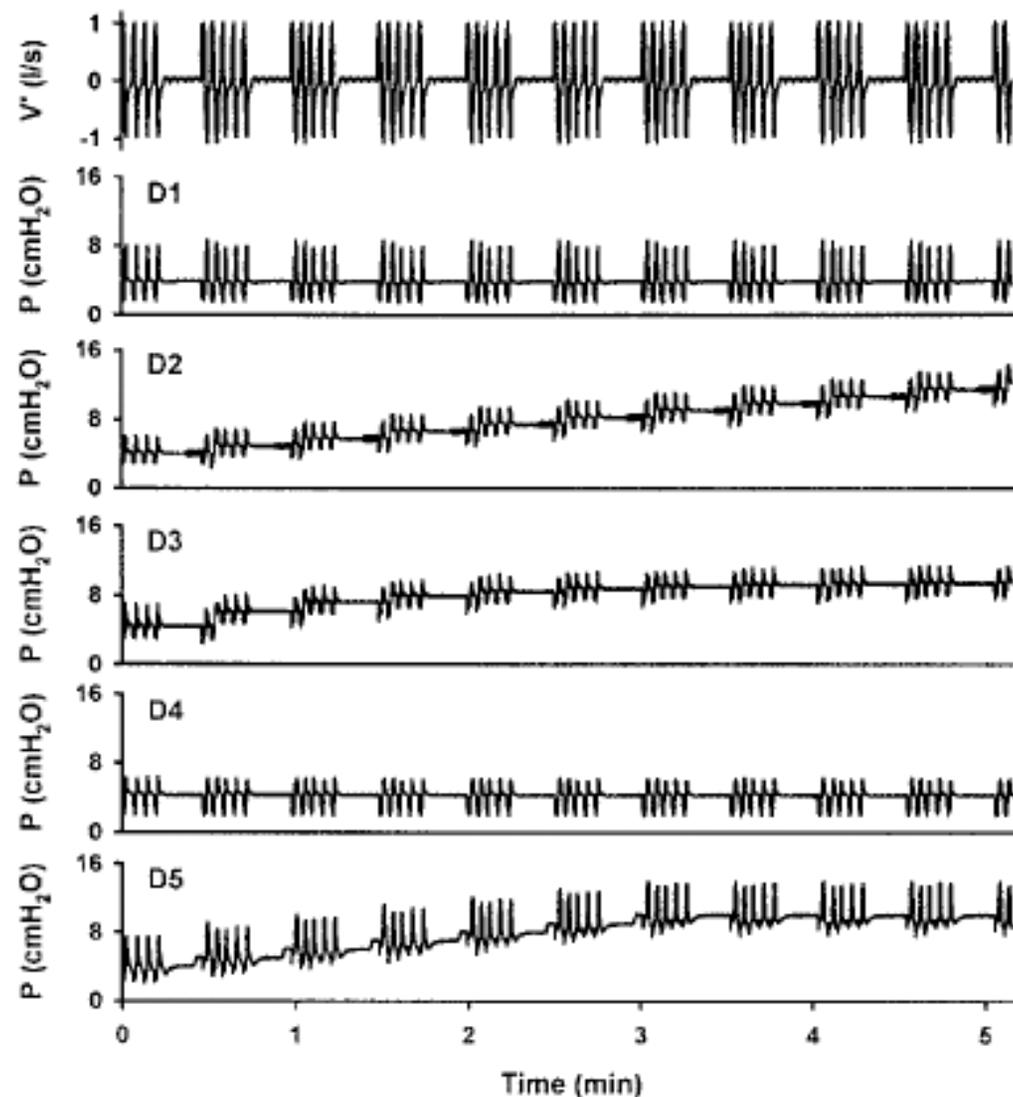


Figure 3. Response of the automatic CPAP devices (D1–D5) when subjected to a flow (V') breathing pattern consisting of repetitive apneas (*Apnea-A* in Figure 2). P and V' are actual pressure and flow, respectively, measured at the entrance of the automatic CPAP devices ($V' > 0$: inspiration).

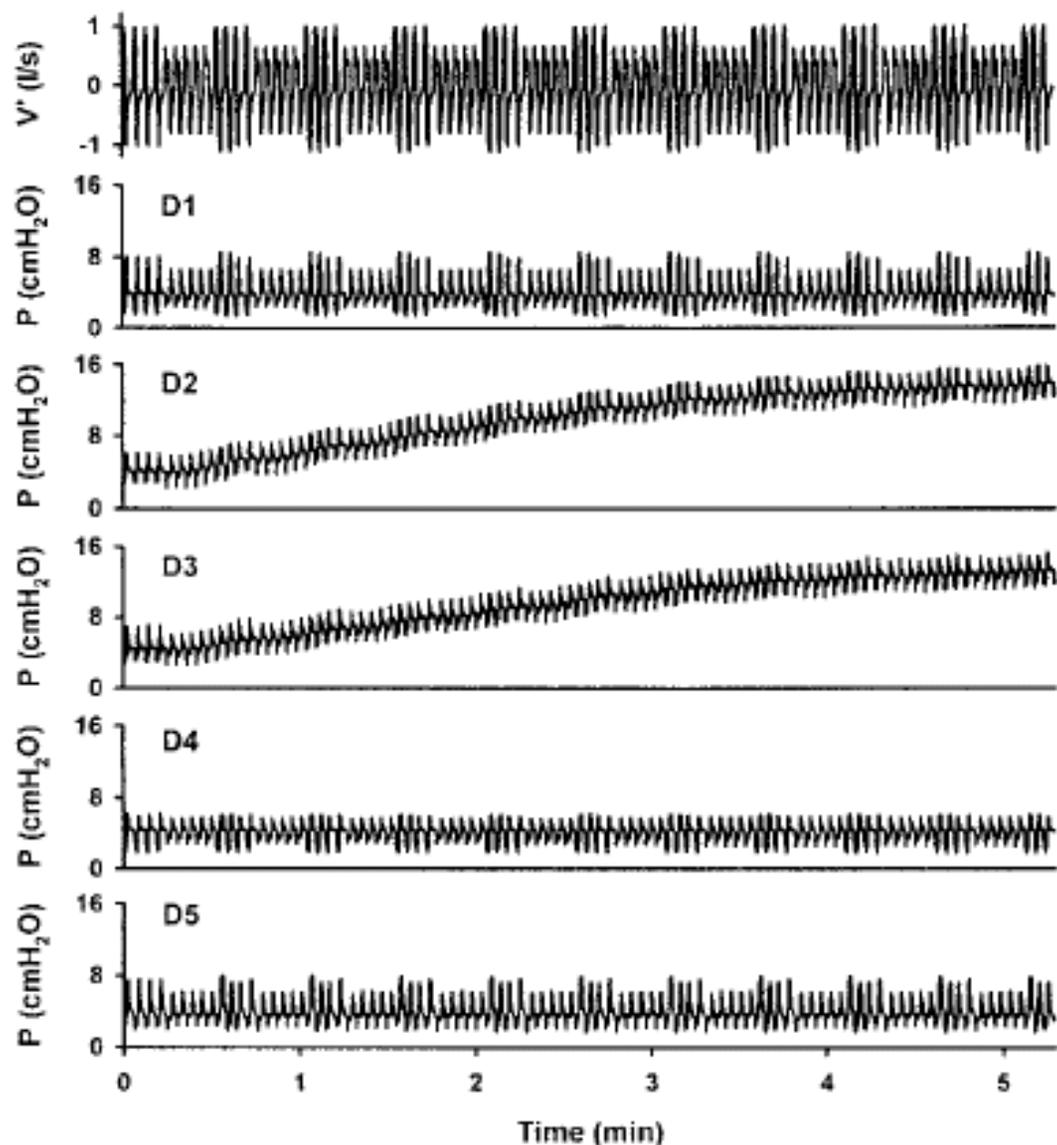


Figure 4. Response of the automatic CPAP devices (D1–D5) when subjected to a flow (displayed as V') breathing pattern consisting of repetitive hypopneas (*Hypo-D* in Figure 2). P and V' are actual pressure and flow, respectively, measured at the entrance of the automatic CPAP devices ($V' > 0$: inspiration).



- ✘ Compare three automatic **nCPAP** devices with **fixed nCPAP** using a crossover protocol
 - ✘ **AutoSet™**®; ResMed, San Diego, CA, USA; using flow limitation in addition to vibration
 - ✘ **Horizon**®; DeVilbiss Sunrise Medical, Inc., Carlsbad, CA, USA; using flow limitation in addition to vibration
 - ✘ **Virtuoso**®; Respironics, Inc., Murrysville, PA, USA; does not utilise a pneumotachograph; using only vibration

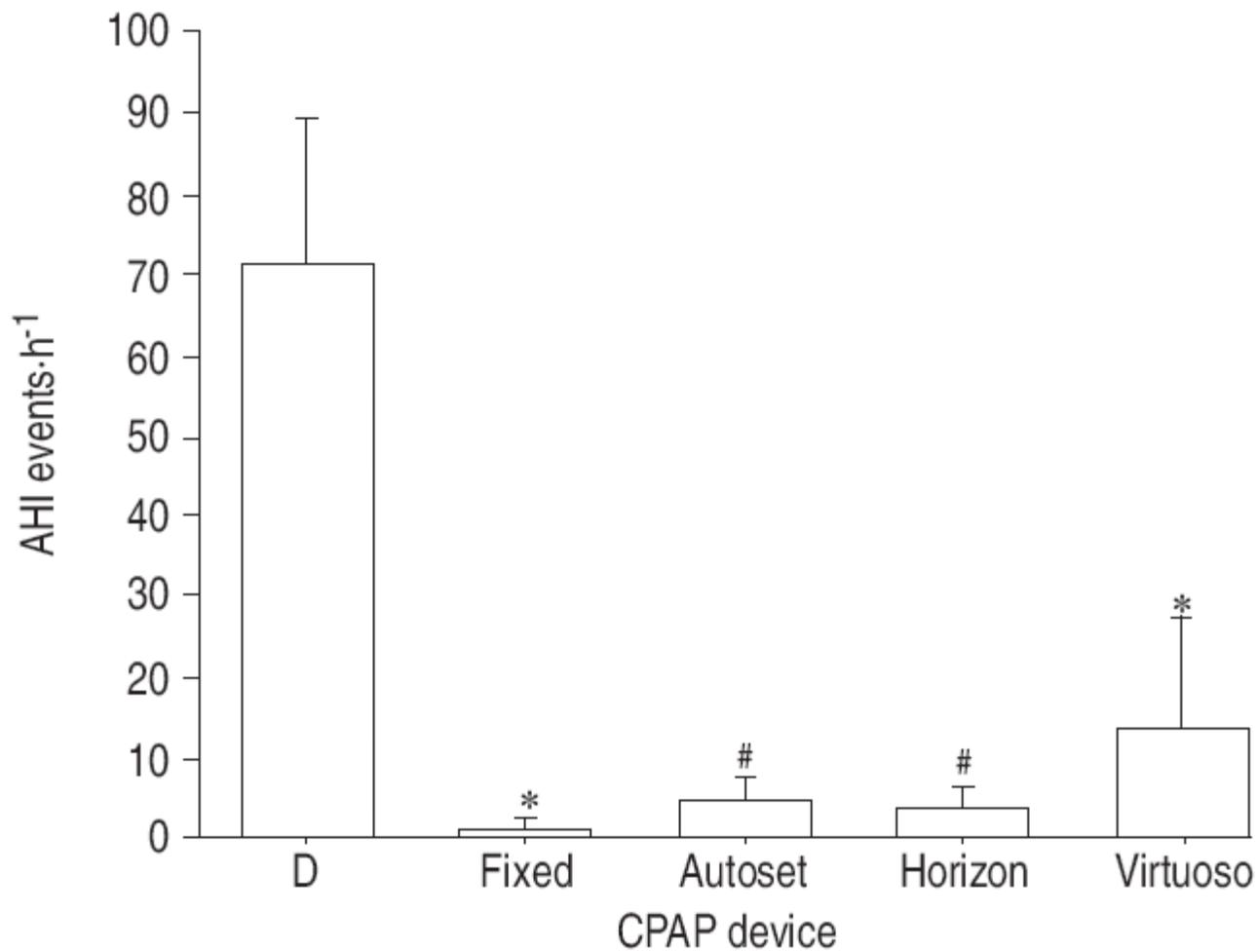


Fig. 1.–Apnoea/hypopnoea index (AHI) during the diagnostic (D) and treatment nights using various continuous positive airway pressure (CPAP) devices. Data are presented as mean±SD. *: $p < 0.05$ versus all other groups; #: $p < 0.05$ versus diagnostic night, fixed CPAP and Virtuoso.

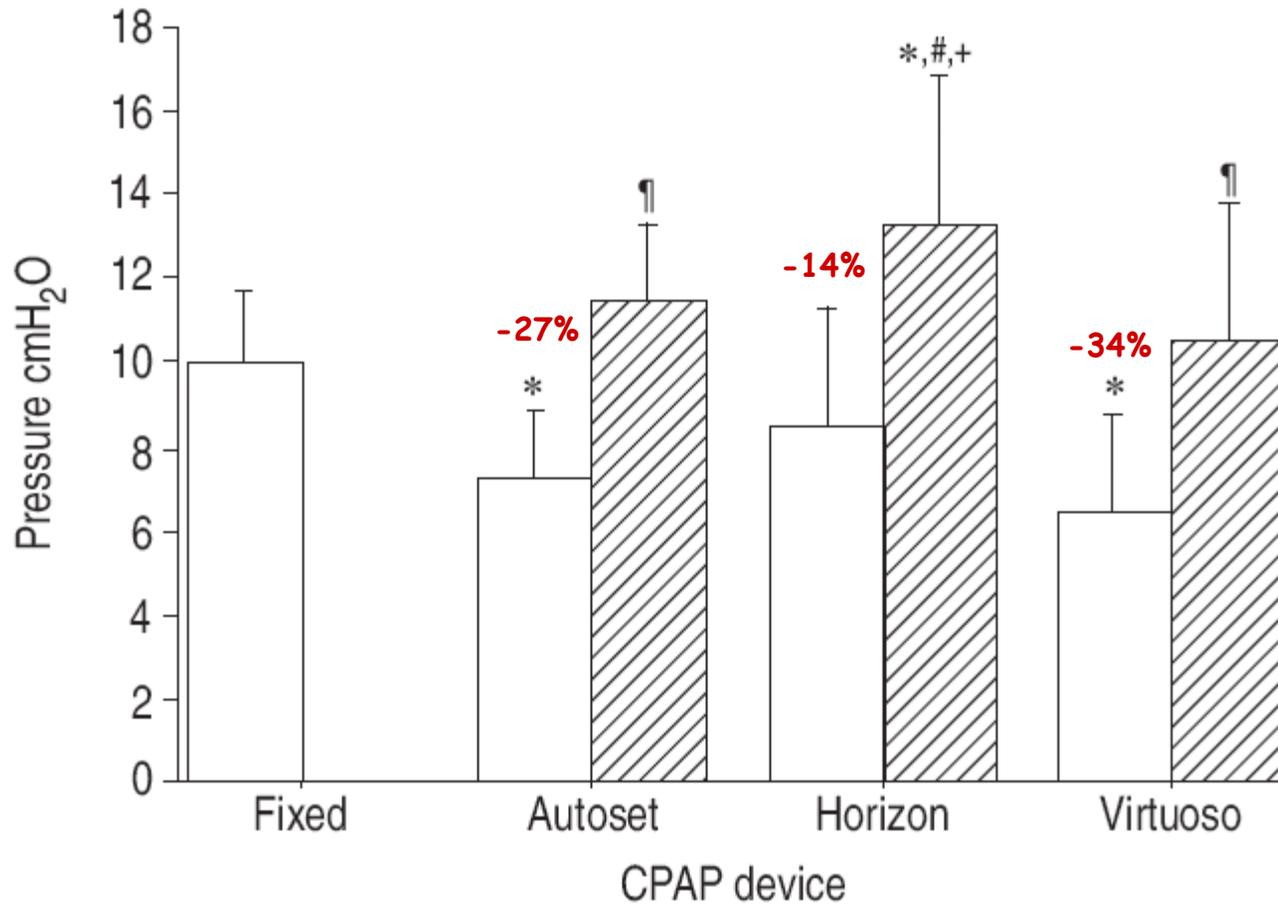


Fig. 4. – Mean (□) and maximum (▨) pressure with the various continuous positive airway pressure (CPAP) devices. Data are presented as mean±SD. *: $p < 0.05$ versus fixed CPAP; #: $p < 0.05$ versus AutoSet; ¶: $p < 0.05$ versus Horizon; +: $p < 0.05$ versus Virtuoso.

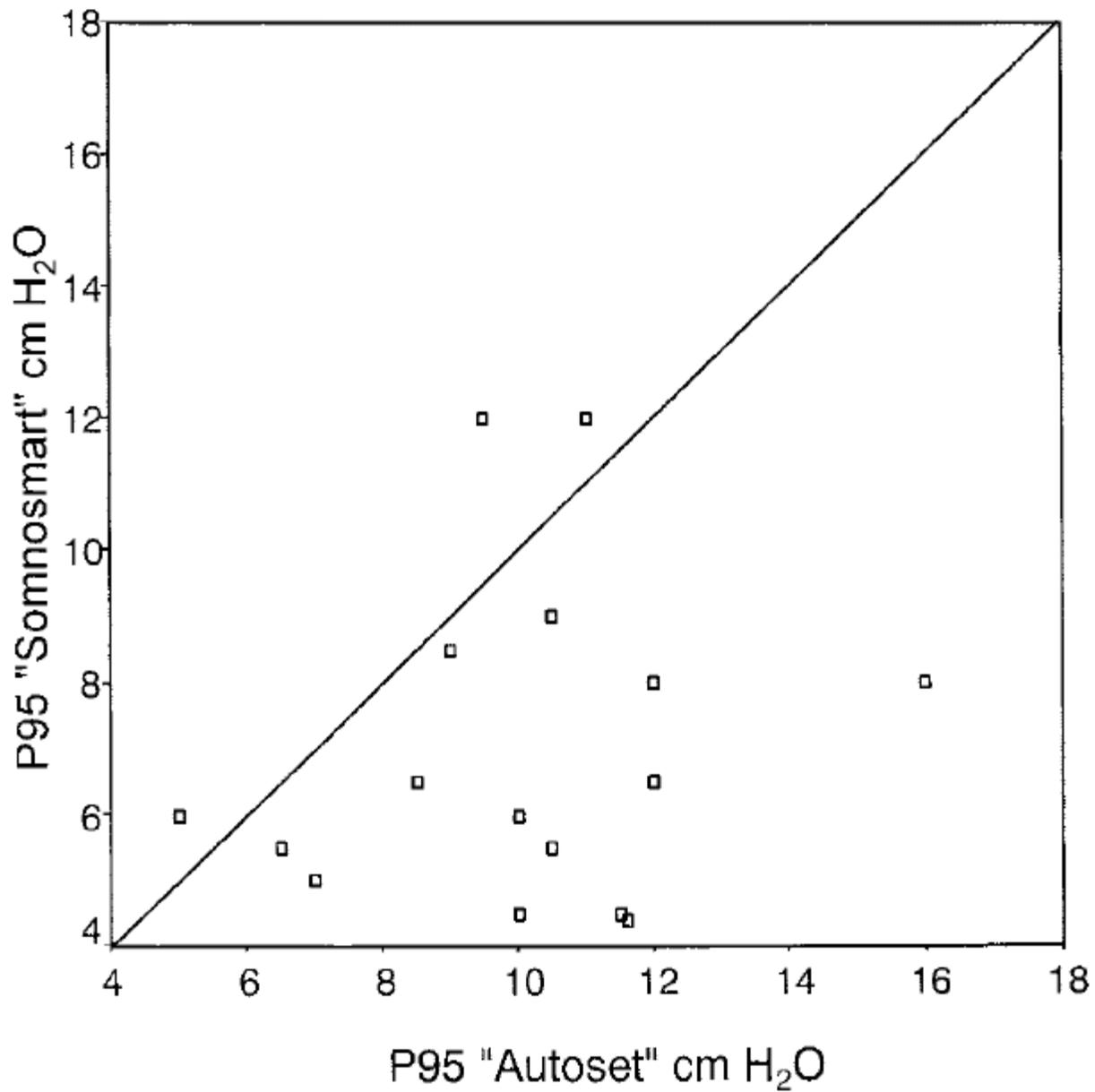
Evaluation of Unattended Automated Titration To Determine Therapeutic Continuous Positive Airway Pressure in Patients With Obstructive Sleep Apnea*



Chest 2003;123;704-710

Romain Kessler, Emmanuel Weitzenblum, Ari Chaouat, Carmen Iamandi and Thierry Alliotte

- ✘ Hospital 2 random nights
- ✘ AutoSet® (Resmed) vs SomnoSmart® (Weinmann)
- ✘ P₉₅
- ✘ Significant differences (AHI: 9.9 +/-2.6 vs 7 +/- 2.5)
- ✘ Lack of agreement



- ✘ One week home titration
- ✘ Cross over
- ✘ GK 420® Tyco (90th) vs
- ✘ AutoSet Spirit® Resmed (95th) vs
- ✘ Rem Star Auto® Respironics (90th)

**Recommended Peff
(cm H₂O)**

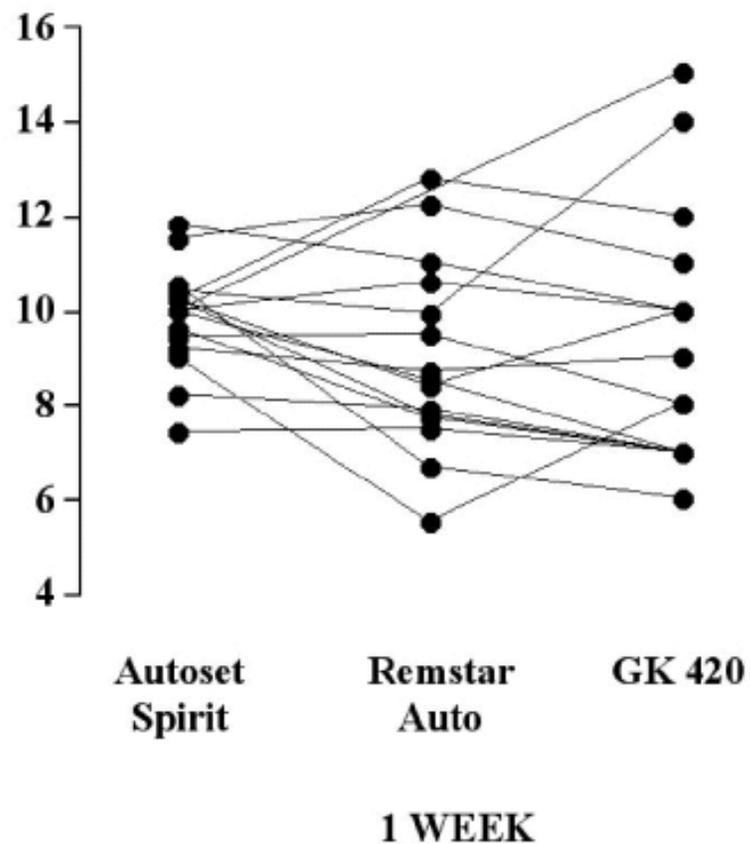
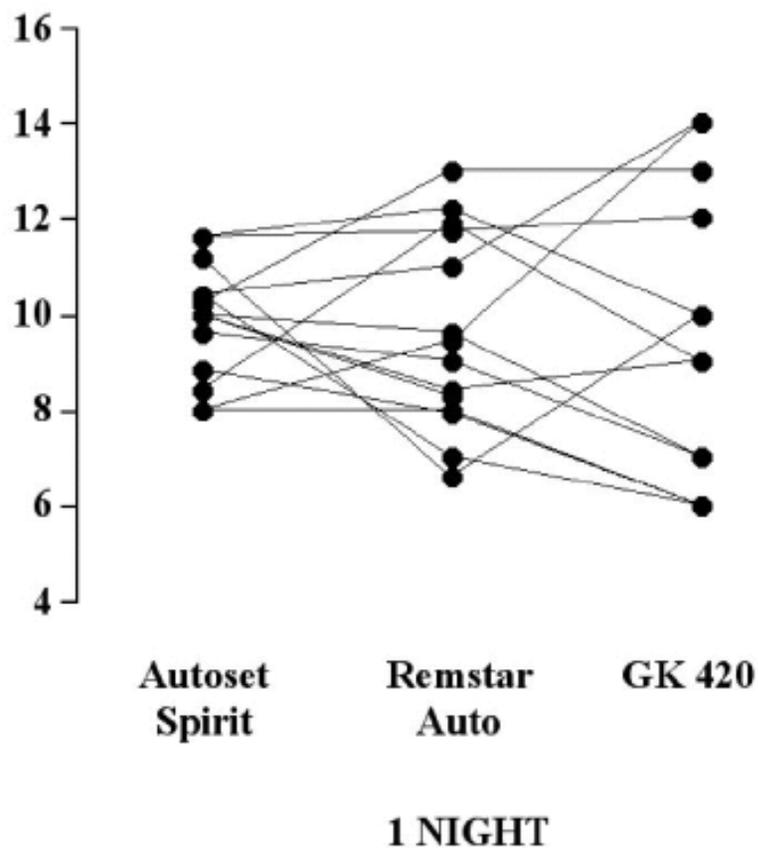


Figure 1
Individual values of the recommended effective pressure (Peff) level obtained after one night and one week of automatic CPAP titration with the three tested apparatus.

The fine art of CPAP titration—will it ever become obsolete?

János Juhász

EDITORIAL

Sleep Breath (2007) 11:65–67

- * There is a margin of **pressure tolerance** around an **optimal CPAP level** in a given patient at a given time (several centimeters of water) Within this conceptual margin, however, pressure adjustments will not appreciably affect sleep or breathing outcomes

CPAP titration: Different methods for similar clinical results

EUROPEAN JOURNAL OF
INTERNAL
MEDICINE

Jose Luis Lopez-Campos^{*}, Cayo Garcia Polo, Antonio Leon Jimenez, Enrique Gonzalez-Moya,
Aurelio Arnedillo, Juan Jose Fernandez Berni

European Journal of Internal Medicine 18 (2007) 230–234

- * **Obsessional titration** on the first(-s) night(-s) **superfluous**
- * Establishing patients successfully on nCPAP depends more on **their training and support** than on the subtle adjustment of NCPAP pressure

Take home messages: Manual or Auto-CPAP?

Manual :

- + Gold standard
- Labour intensive, time consuming, and expensive
- Information during one single night in a dedicated environment

Auto-CPAP :

- + Cost and time saving
- + Substantial clinical equivalency between manual and Auto-CPAP titrations
- Selected patients
- Caution should be exercised in selecting a particular device : APAP must be robust and reliable, adequate knowledge of the technique must be ensured

Questions...?



Département de Médecine Interne
Service de Pneumologie



Rencontres Genevoises de Pneumologie

Rencontre d'hiver

**Apnées du sommeil:
quoi de neuf?**

Mercredi 18 février 2009,
13H00-17H00, salle 7A-7-731/732

Formation continue de Pneumologie aux HUG



✘ Clinical prediction: formulas

✘ Manual titration

✘ Full night PSG

✘ Split night PSG

✘ Daytime CPAP titration

✘ Auto-CPAP titration

✘ In-laboratory attended

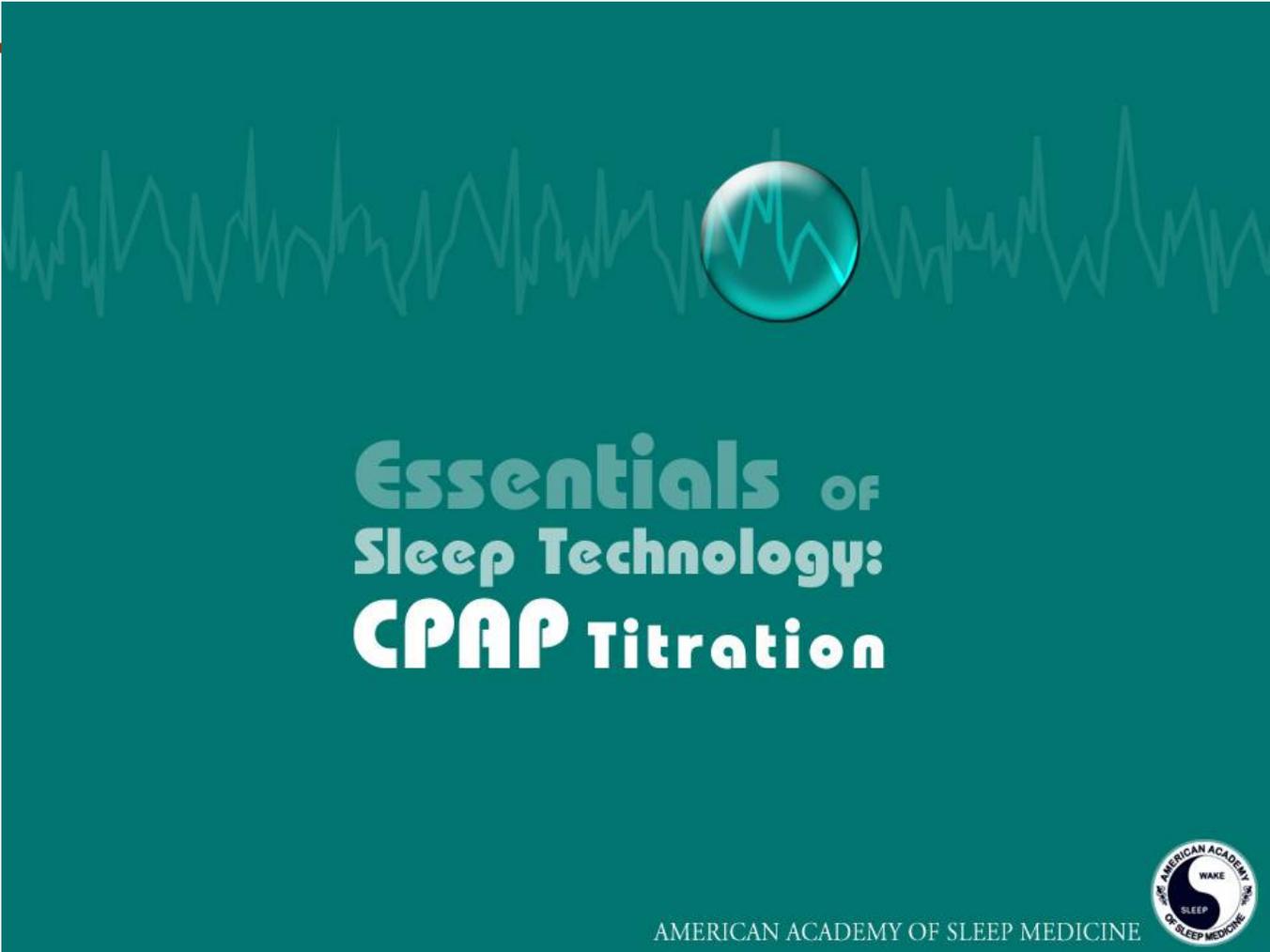
✘ Unattended home

TABLE 1. RESPONSE OF THE AUTOMATIC CPAP DEVICES WHEN SUBJECTED TO DIFFERENT BREATHING PATTERNS

Breathing Pattern	Automatic CPAP Device				
	D1	D2	D3	D4	D5
Repetitive events					
Apnea-A	—	↑	↑	—	↑
Hypo-A	—	—	—	—	—
Hypo-A + Snoring	↑	↑	↑	↑	—
Hypo-B	—	—	—	—	↑
Hypo-C	—	↑	↑	—	—
Hypo-D	↑	↑	↑	—	—
Prolonged flow limitation					
Hypo-A	—	—	—	—	—
Hypo-A + Snoring	↑	↑	↑	↑	↑
Hypo-C	—	↑	↑	—	—
Hypo-C + Snoring	↑	↑	↑	↑	↑
CPAP-dependent events	—	↑	↑	—	—

Definition of abbreviation: CPAP = continuous positive airway pressure.

D1, D2, D3, D4, and D5 are the different automatic CPAP devices tested. The different breathing patterns are described in the text. The device increased (↑) or did not modify (—) CPAP when subjected to the breathing pattern.



**Essentials of
Sleep Technology:
CPAP Titration**

AMERICAN ACADEMY OF SLEEP MEDICINE



**American Academy of Sleep Medicine
November 2005**

The American Thoracic Society, the American College of Chest Physicians and the AASM

CPAP titration by an auto-CPAP device based



on snoring detection: a clinical trial and economic

M. Berkani, F. Lofaso, C. Chouaid, M. Pia d'Ortho, D. Theret, V. Grillier-Lanoir, A.
Eur Respir J 1998; 12: 759-763

- ✘ AutoSet® clinical (ResMed, Sydney, Australia)
- ✘ Ambulatory polysomnography 2 weeks after initiating nCPAP treatment at the same fixed pressure
- ✘ The highest pressure obtained during titration was therefore considered as the minimum fixed pressure required to prevent upper airway narrowing.
- ✘ All patients started nCPAP treatment with this fixed pressure for 2 weeks and then underwent, in a conventional hospital room, another ambulatory full polysomnography to determine the efficacy of this fixed-pressure device, i.e. constant nCPAP treatment.