



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

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## KEYWORDS

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**Summary** When treating Obstructive Sleep Apnea–Hypopnea Syndrome (OSAHS) several alternatives for standard (manual) continuous positive airway pressure (CPAP) titration are feasible. A practical alternative is titration without polysomnography during an afternoon nap (Nap-titration). The aim of the present study was to assess whether Nap-titration is appropriate for effective titration of CPAP.

Following Nap-titration 24 eligible OSAHS patients started conventional CPAP therapy. The outcome of Nap-titration was verified after 2 weeks with CPAP pressure adjustments being performed in case of persisting OSAHS symptomatology. Polysomnography and a questionnaire evaluation were performed at baseline and 8 weeks after Nap-titration.

Following Nap-titration 15 patients did not require pressure changes while in 9 patients' CPAP pressure was raised due to persisting OSAHS symptomatology. Control polysomnography after 8 weeks showed successful CPAP titration (Apnea–Hypopnea Index < 5) in 23 out of 24 patients. A pressure raise following polysomnography was indicated in 1 patient only. In addition, significant improvements were found in OSAHS symptomatology and quality of life.

This study shows that in 96% of OSAHS patients' successful CPAP titration is attained following Nap-titration whether or not supplemented by pressure

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adjustments. Therefore, Nap-titration with an adequate follow-up appears an appropriate procedure for the effective titration of CPAP.

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## Introduction

The Obstructive Sleep Apnea–Hypopnea Syndrome (OSAHS) is a highly prevalent sleep-related breathing disorder associated with serious neurocognitive and cardiovascular sequelae.<sup>1</sup> continuous positive airway pressure (CPAP) is currently recommended as the treatment of choice for moderate to severe OSAHS.<sup>1</sup> CPAP prevents obstructed breathing events by pneumatically “splinting” the upper airway during sleep. Determination of the effective CPAP pressure ( $P_{\text{eff}}$ ) is usually a trade-off between the minimisation of pressure-related side-effects and the prevention of obstructed breathing events. This procedure, known as CPAP titration, is routinely conducted by a technician in a sleep laboratory during attended full-night polysomnography (i.e. manual titration).<sup>2</sup> Manual CPAP titration aims at identifying the pressure that eliminates apneas, hypopneas and snoring in all body positions and sleep stages. Alternative goals in CPAP titration include the minimisation of oxygen desaturations, (micro)arousals and inspiratory flow limitations.<sup>3</sup> However, currently there are no widely accepted guidelines on the standardisation of manual CPAP titration.

Several alternatives for manual titration have emerged to shorten waiting lists for polysomnography and to improve cost-effectiveness of CPAP titration. Split-night polysomnography for the diagnosis of OSAHS and titration of CPAP was introduced to expedite initiation of therapy and control costs related to polysomnography.<sup>4</sup> Daytime manual CPAP titration during polysomnography has also been shown a viable alternative for the efficient and expedient implementation of CPAP in OSAHS patients.<sup>5</sup> Alternative means of titration not requiring polysomnography include home self-titration of CPAP based on the detection of snoring or the patient’s perception of therapeutic comfort and efficacy.<sup>6</sup> Other alternative titration procedures are based on night time respiratory recordings or employ prediction equations for  $P_{\text{eff}}$  based on polysomnographic and demographic variables.<sup>7,8</sup> Moreover, effective CPAP titration not requiring polysomnographic monitoring has also been performed by means of automatic CPAP devices.<sup>8,9</sup>

A practical alternative for manual CPAP titration, especially when polysomnography can only be conducted ambulatory, is titration without

polysomnography during an afternoon nap (Nap-titration). In our experience Nap-titration determines an adequate  $P_{\text{eff}}$  for subsequent CPAP therapy, although this has not been demonstrated previously. The aim of the present study was to assess whether Nap-titration is appropriate for effective titration of CPAP in OSAHS patients.

## Methods

### Patients

Twenty-nine consecutive patients diagnosed with OSAHS were considered for inclusion in the present study. Only “CPAP-naive” patients with an Apnea–Hypopnea Index (AHI) exceeding 5 were eligible for inclusion. Patients were excluded in case of previous OSAHS treatment (1 patient; Oral Appliance therapy), morphological upper airway abnormalities requiring surgery (1 patient; adenotonsillar hypertrophy), endocrine dysfunction (1 patient; hypothyroidism), predominant central respiratory events during polysomnography, moderate Periodic Limb Movement Disorder (i.e. Periodic Limb Movement Index > 25) or a psychological condition precluding informed consent. Of the remaining 26 patients, one refused participation and one discontinued treatment shortly following CPAP titration because of non-compliance. Baseline characteristics and CPAP-titration data of the 22 male and 2 female patients completing the protocol are summarised in Table 1. The study was approved by the University Medical Center Groningen ethics board. Written informed consent was obtained from each participant before initiation of the protocol.

### Protocol

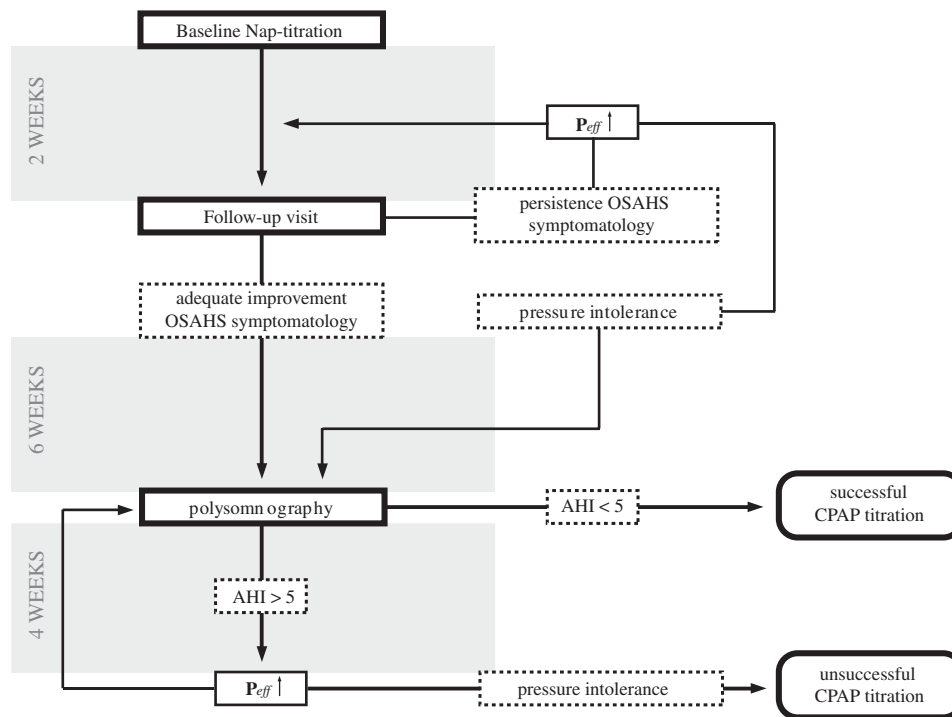
The titration algorithm employed in the present study is outlined in Fig. 1. At baseline all included patients were subjected to a basic physical examination and questionnaire evaluation. Before CPAP titration during an afternoon nap, patients received detailed instructions on the titration procedure and CPAP use by a skilled nursing consultant. During Nap-titration patients were allowed to sleep with CPAP in the outpatient clinic for a 2-h period. Patients were instructed to adopt

**Table 1** Patient characteristics and CPAP-titration data.

	Baseline ( <i>n</i> = 24) Mean $\pm$ SD	Follow-up* ( <i>n</i> = 24) Mean $\pm$ SD	Difference <i>P</i> value
Age (year)	50.2 $\pm$ 8.1	—	—
BMI (kg/m <sup>2</sup> )	34.4 $\pm$ 6.9	34.2 $\pm$ 6.5	ns
NC (cm)	46.0 $\pm$ 4.1	45.4 $\pm$ 3.7	ns
<i>P</i> <sub>eff</sub> (cm H <sub>2</sub> O)	7.0 $\pm$ 1.6	7.6 $\pm$ 1.6	0.004
Titration duration (h)	2.1 $\pm$ 0.2	—	—

Abbreviations: BMI = Body Mass Index; NC = neck circumference; ns = non-significant; *P*<sub>eff</sub> = effective CPAP pressure level; SD = standard deviation.

\*Values corresponding with the last polysomnographic CPAP evaluation.



**Figure 1** Titration algorithm. Abbreviations: AHI = Apnea–Hypopnea Index; CPAP = Continuous Positive Airway Pressure; OSAHS = Obstructive Sleep Apnea–Hypopnea Syndrome; *P*<sub>eff</sub> = effective CPAP pressure level. Two weeks following Nap-titration patients return for a follow-up visit. When OSAHS symptomatology has improved adequately (i.e. a resolution of snoring and improvement in excessive daytime sleepiness), a polysomnographic evaluation is arranged in 6 weeks. When OSAHS symptomatology persists, CPAP pressure is raised with 1 increment whereupon a (telephonic) follow-up appointment is arranged after 1 week. Pressure adjustments are continued until OSAHS symptomatology has improved adequately or until patients complain of pressure intolerance. Thereupon a polysomnographic evaluation is arranged in 6 weeks. In patients displaying an AHI < 5 at polysomnography, CPAP therapy is considered successful. In case of an AHI > 5, CPAP pressure is raised with one or two increments whereupon a second polysomnographic evaluation is performed in 4 weeks. This pressure adjustment sequence is continued until CPAP is successfully titrated or until patients complain of pressure intolerance.

their own typical sleeping habits during titration. CPAP pressure was initially set at 5 cm H<sub>2</sub>O. During Nap-titration the nursing consultant checked every 15 min and intervened in case of difficulties. At each check CPAP pressure was raised with an 0.5 cm H<sub>2</sub>O increment whenever upper airway breathing

events remained noticeable (i.e. audible or visible signs of apneas, hypopneas or snoring). If after 2 h of Nap-titration the established *P*<sub>eff</sub> resolved all breathing events, CPAP titration was terminated. If not, titration was continued as described above for as long as upper airway breathing events remained

noticeable. In case patients were unable to sleep during (part of) the titration period, the CPAP pressure established last was used as  $P_{\text{eff}}$ . Following Nap-titration CPAP therapy (Breas<sup>®</sup> PV10, Mölnlycke, Sweden) was started with the established  $P_{\text{eff}}$ .

Two weeks after CPAP initiation patients returned for their first follow-up visit. Possible difficulties with the CPAP apparatus were resolved and treatment efficacy was verified. When treatment progressed without difficulties and OSAHS symptomatology had improved adequately (i.e. a resolution of snoring and improvement in excessive daytime sleepiness (EDS)), a second follow-up visit and polysomnographic evaluation was arranged in 6 weeks. In case patients reported persistence in OSAHS symptomatology, CPAP pressure was raised with one increment. To monitor the outcome of the pressure adjustment, a (telephonic) follow-up appointment was arranged after 1 week. The latter adjustment sequence was repeated until a  $P_{\text{eff}}$  was obtained that adequately improved OSAHS symptomatology or until further pressure adjustments were poorly tolerated by patients. Subsequently, a follow-up visit and polysomnographic evaluation was arranged in 6 weeks.

Based on the polysomnographic evaluation of the  $P_{\text{eff}}$  established during follow-up, it was decided whether CPAP titration was successful. In patients displaying an  $\text{AHI} < 5$ , CPAP therapy was considered successful. Subsequently, the basic physical examination and questionnaire evaluation performed at baseline were repeated. In case polysomnography yielded an  $\text{AHI} > 5$ , CPAP titration was continued. For this purpose CPAP pressure was arbitrarily raised with one or two increments (depending on the severity of residual OSAHS with CPAP). Four weeks following the adjustment in  $P_{\text{eff}}$  a second polysomnographic evaluation was performed. This latter adjustment sequence was continued until OSAHS was successfully managed ( $\text{AHI} < 5$ ) or until further pressure adjustments were poorly tolerated by patients. Subsequently, the basic physical examination and questionnaire evaluation performed at baseline were repeated.

### Polysomnographic evaluation

Baseline and follow-up polysomnography was conducted ambulatory using the Embla<sup>®</sup> A10 digital recorder (Medcare, Reykjavik, Iceland). Each recording started (no later than) 11 AM and terminated 9 AM the next morning. Surface electroencephalography, submental electromyography (EMG), and left and right electrooculogra-

phy were used to stage sleep according to standardised criteria.<sup>10</sup> A pulseoximeter (Oximeter Flex Sensor—8000J-3, Medcare, Reykjavik, Iceland) was used to record oxyhemoglobin saturation ( $\text{SaO}_2$ ) while electrocardiography was used to monitor cardiac function. Oronasal airflow was recorded with a pressure cannula, while respiratory effort was monitored by thoracic and abdominal strain gauges. An anterior tibial EMG was recorded to screen for periodic limb movements. Standardised criteria were used to score breathing events.<sup>11</sup> All recordings were scored by one interpreter (JHvdH) who was not informed about the nature of the recording. Outcomes were limited to the time in bed of the nocturnal part of the recording.

### Questionnaire evaluation

At baseline and following the last polysomnographic evaluation patients completed the OSAHS-related symptoms questionnaire, Epworth Sleepiness Scale (ESS), Functional Outcomes of Sleep Questionnaire (FOSQ), Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) and Hospital Anxiety and Depression Scale (HADS).<sup>12–16</sup> CPAP compliance was evaluated by asking patients how many nights per week and, in addition to their mean hours of sleep per night, how many hours per night CPAP was used. In addition, patients graded their treatment satisfaction with CPAP on an eleven point scale (range 0–10; higher scores indicating better satisfaction).

### Analysis

The  $\text{AHI}$  was used as primary outcome measure with treatment being considered successful in case of an  $\text{AHI} < 5$ . Statistical analyses were performed using the StatsDirect software package version 2.2.3 (Cheshire, UK). Data are summarised by their mean and standard deviation ( $\text{SD}$ ). Differences between baseline and follow-up variables were compared with paired Student's  $t$ -tests. A significance level of  $P < 0.05$  was predefined in all cases (two-sided  $P$  value).

### Results

Patient characteristics and CPAP-titration data are summarised in Table 1. CPAP titration lasted 2.1 h ( $\text{SD} = 0.2$ ) on average and required more than 2 h in 4 patients (range  $2\frac{1}{4}$ –3 h). All patients reported to have slept during the predominant part of the

titration period. Following titration the  $P_{\text{eff}}$  was set at 7.0 cm ( $SD = 1.6$ )  $H_2O$ . However, during follow-up after Nap-titration, pressure changes were required in 9 patients due to a persistence in OSAHS symptomatology (4 patients persistence snoring, 5 patients no improvement EDS). Consequently, CPAP pressure had to be raised with 1 increment in 7 patients, and with 2 and 4 increments, respectively, in the remaining 2 patients. In addition, due to a persistence of OSAHS at the first polysomnographic evaluation, CPAP pressure was raised with 1 increment in a 10th patient. Consequently, the mean  $P_{\text{eff}}$  at the end of the study period was set at 7.6 cm ( $SD = 1.6$ )  $H_2O$ , resulting in a significant difference between the baseline and follow-up  $P_{\text{eff}}$ .

### Polysomnographic outcomes

Polysomnographic data are summarised in Table 2. With respect to the primary outcome measure, successful treatment with CPAP (i.e.  $AHI < 5$ ) was attained in 23 patients at the first polysomnographic evaluation. In the one patient failing the criterion for successful CPAP-titration the  $AHI$  decreased from 51 to 7. However, following a 1-increment pressure raise, the second polysomnographic evaluation also indicated successful OSAHS management. No significant changes in total sleep time or sleep efficiency were observed between baseline and follow-up. However, as a result of CPAP profound improvements in the  $AHI$  and  $MinSaO_2$  were observed. Although no significant changes in non-rapid eye movement (REM) sleep stage 1 were observed, the percentage non-REM sleep stage 2 significantly decreased and the percentage non-REM sleep stage 3 and 4 and REM

sleep significantly increased as a result of CPAP initiation.

### Questionnaire outcomes

Questionnaire data are summarised in Table 3. With respect to the OSAHS-related symptoms questionnaire and sleepiness according to the ESS, significant improvements were seen in response to the initiation of CPAP therapy. In addition, significant improvements in excessive sleepiness in all five subscales of the FOSQ were seen as a result of CPAP initiation. Conversely, variable outcomes with respect to the eight SF-36 dimensions were observed. Whereas role emotional and bodily pain did not change significantly, CPAP therapy resulted in significant improvements in the remaining six SF-36 dimensions. With respect to patient anxiety and depression, both subscales of the HADS showed significant improvements as a result of CPAP initiation.

Except for 3, all studied patients reported using their CPAP apparatus 7 nights per week (mean 6.9 days,  $SD = 0.3$ ). During therapeutic nights patients reported using their CPAP apparatus for a 6.9 h ( $SD = 1.5$ ) period. When dividing these values by the patient reported hours of sleep per night (mean 7.3 h,  $SD = 1.6$ ), this corresponded with a mean CPAP use of 96% of each therapeutic night. In addition, when using CPAP no patient reported using therapy less than 5 h per night. Twenty-three out of the 24 patients completing the protocol were satisfied with the effects of CPAP therapy. Patients graded their treatment satisfaction with a mean of 8.1 ( $SD = 1.3$ ) points.

**Table 2** Polysomnographic outcomes.

	Baseline ( $n = 24$ ) Mean $\pm$ SD	Follow-up* ( $n = 24$ ) Mean $\pm$ SD	Difference $P$ value
TST (min)	382.5 $\pm$ 85.0	392.7 $\pm$ 64.6	ns
Sleep efficiency <sup>†</sup> (%)	81.3 $\pm$ 17.1	84.7 $\pm$ 10.0	ns
AHI (no/h)	46.6 $\pm$ 29.4	1.1 $\pm$ 1.7	<0.0001
MinSaO <sub>2</sub> (%)	76.3 $\pm$ 11.9	90.8 $\pm$ 4.5	<0.0001
non-REM 1 (%)	9.2 $\pm$ 12.9	5.6 $\pm$ 3.0	ns
non-REM 2 (%)	60.2 $\pm$ 16.6	47.6 $\pm$ 10.8	0.009
non-REM 3 (%)	5.3 $\pm$ 7.6	9.8 $\pm$ 4.3	0.02
non-REM 4 (%)	7.3 $\pm$ 9.7	12.7 $\pm$ 6.3	0.02
REM (%)	18.1 $\pm$ 8.1	24.3 $\pm$ 5.5	0.007

Abbreviations: AHI = Apnea-Hypopnea Index ; MinSaO<sub>2</sub> = minimum oxyhemoglobin saturation; ns = non-significant; REM = rapid eye movement; SD = standard deviation; TST = total sleep time.

\*Values corresponding with the last polysomnographic CPAP evaluation.

<sup>†</sup>Sleep efficiency; TST/time in bed  $\times$  100%.

**Table 3** Questionnaire outcomes.

	Score-range	Direction of improvement	Baseline ( <i>n</i> = 24) Mean ± SD	Follow-up* ( <i>n</i> = 24) Mean ± SD	Difference <i>P</i> value
OSAHS-related symptoms	15–60	–	46.0 ± 5.3	27.7 ± 6.2	<0.0001
ESS	0–24	–	16.5 ± 4.7	6.3 ± 4.6	<0.0001
FOSQ:					
General productivity	1–4	+	2.7 ± 0.8	3.5 ± 0.6	<0.0001
Social outcome	1–4	+	2.7 ± 1.1	3.5 ± 0.8	<0.0001
Activity level	1–4	+	2.4 ± 0.7	3.4 ± 0.7	<0.0001
Vigilance	1–4	+	2.2 ± 0.8	3.4 ± 0.7	<0.0001
Intimate relationships & sexual activity <sup>†</sup>	1–4	+	2.5 ± 1.0	3.2 ± 1.1	0.006
SF-36:					
Physical functioning	0–100	+	62.5 ± 27.6	79.4 ± 23.1	0.0005
Social functioning	0–100	+	62.7 ± 23.9	76.7 ± 21.2	0.0004
Role physical	0–100	+	30.2 ± 41.7	70.8 ± 40.8	0.0001
Role emotional	0–100	+	66.0 ± 43.0	80.5 ± 36.7	ns
Mental health	0–100	+	64.0 ± 18.8	78.3 ± 17.3	0.0002
Vitality	0–100	+	33.3 ± 19.8	61.7 ± 21.8	<0.0001
Bodily pain	0–100	+	77.5 ± 27.6	79.8 ± 26.8	ns
General health perception	0–100	+	52.3 ± 22.6	61.0 ± 23.6	0.04
HADS:					
Anxiety	0–21	–	5.9 ± 3.9	4.1 ± 3.0	0.006
Depression	0–21	–	8.6 ± 3.9	5.5 ± 4.8	<0.0001

Abbreviations: ESS = Epworth Sleepiness Scale; FOSQ = Functional Outcomes of Sleep Questionnaire; HADS = Hospital Anxiety and Depression Scale; ns = non-significant; OSAHS = Obstructive Sleep Apnea-Hypopnea Syndrome; SD = standard deviation; SF-36 = Medical Outcomes Study 36-Item Short-Form Health Survey.

\*Values corresponding with the last polysomnographic CPAP evaluation.

<sup>†</sup>*n* = 21 because 3 patients did not complete this item at baseline and follow-up.

## Discussion

The present study shows that titration conducted without polysomnography during an afternoon nap is an appropriate procedure for the effective titration of CPAP in OSAHS patients. In addition to favourable changes in respiratory and sleep related variables, Nap-titration also resulted in profound improvements of OSAHS symptomatology. However, because in 38% of the patients pressure adjustments are indicated following Nap-titration due to persisting OSAHS symptomatology, an adequate follow-up is a prerequisite.

With respect to the primary outcome measure, Nap-titration was successful in yielding an AHI < 5 in nearly all patients following the first polysomnographic evaluation. In addition, successful OSAHS management was attained in all 24 patients following a correction of the  $P_{\text{eff}}$  in 1 patient. The observed improvements in the AHI are consistent with results from other studies following manual

CPAP titration.<sup>17,18</sup> In addition, the improvements in MinSaO<sub>2</sub> are also in keeping with improvements observed following manual CPAP titration.<sup>17,19</sup> Polysomnography following CPAP titration showed significant changes in non-REM sleep stage 2, 3 and 4, and REM-sleep. These findings suggest pronounced improvements in sleep architecture that correspond with the effects of CPAP following manual titration.<sup>17–19</sup>

In accordance with the polysomnographic outcomes, most of the questionnaire outcomes significantly improved following adequate CPAP titration. The OSAHS-related symptom questionnaire indicated significant improvements in OSAHS symptomatology that correspond with other studies following manual CPAP titration.<sup>12,20</sup> In addition, changes in the ESS and FOSQ values indicated pronounced improvements in excessive sleepiness that also correspond with the effects of CPAP following manual titration.<sup>12,20,21</sup> Except for 2 (i.e. role emotional and bodily pain), Nap-titration

resulted in a significant improvement of health status in all SF-36 dimensions. Although some studies show improvements in all SF-36 dimensions as a result of manual CPAP titration,<sup>21</sup> other studies fail observing such consistent improvements.<sup>20</sup> Since the changes in the SF-36 are reported rather inconsistently, comparison of our findings probably does not add to the discussion. Finally, following adequate CPAP titration small but significant improvements in both patient anxiety and depression were observed that correspond with the effects of CPAP following manual titration.<sup>22</sup> However, these latter improvements may also be a resultant of a placebo effect of CPAP therapy.<sup>22</sup> The observed improvements in questionnaire outcomes following Nap-titration once again stress the favourable value of CPAP therapy on patient symptomatology and quality of life. Both items being important aspects for obtaining resources for sleep respiratory medicine.

With economic and practical issues impinging upon its feasibility, there is an increasing need for appropriate alternatives to manual CPAP titration.<sup>23</sup> Of the various alternatives propagated, titration of  $P_{\text{eff}}$  during an afternoon nap is a relatively novel procedure. Daytime CPAP titration has been described previously for the efficient implementation of CPAP therapy.<sup>5</sup> However, in most of these studies daytime titration was performed during laboratory polysomnography and required more than 4h. Others have suggested CPAP titration may be performed in a pulmonary department using Auto-CPAP devices.<sup>9</sup> Although sleep laboratory intervention may be obviated in this way, patients are still required to spend the night in hospital. An alternative means of titration not requiring polysomnography nor overnight admission is home self-titration of CPAP based on the detection of snoring or perception of therapeutic comfort and efficacy.<sup>6</sup> However, self-titration of CPAP may be regarded as a somewhat arbitrary means for establishing a  $P_{\text{eff}}$ . Split-night polysomnography was introduced to expedite therapeutic intervention and control (polysomnographic) costs. Nevertheless, split-night polysomnography must be performed under sleep-laboratory conditions and may still require a change in the prescribed pressure.<sup>4</sup> In addition, alternative means of CPAP titration that employ prediction equations for  $P_{\text{eff}}$  based on polysomnographic and anthropometric variables, may still require adjustments in CPAP pressure in 28% of patients because of persisting OSAHS symptomatology.<sup>8</sup> Nap-titration with an adequate follow-up regime allowed for adequate CPAP titration in an outpatient setting. Therefore, Nap-titration does not require access to a

sleep-laboratory nor time-consuming titration procedures. Because polysomnography indicated successful CPAP titration in 23 out of 24 patients at follow-up, a polysomnographic CPAP evaluation following Nap-titration does not appear obligatory. Thereby, polysomnographic control recordings may be reserved for specific cases (e.g. persisting OSAHS symptomatology despite apparent adequate titration). Moreover, provided adequate knowledge of pulmonary medicine and respiratory support is present, Nap-titration may be performed by nursing consultants.

The  $P_{\text{eff}}$  attained at the end of the study period (i.e. 7.6 cm H<sub>2</sub>O,  $SD = 1.6$ ) is comparable to pressures obtained with manual CPAP titration in patients with similar OSAHS gravity.<sup>5,17</sup> Despite the adequate  $P_{\text{eff}}$ , pressure changes were required in a considerable proportion of patients following Nap-titration. The latter was indicated due to the persistence in OSAHS symptomatology in 9 patients following Nap-titration and OSAHS persistence following the polysomnographic evaluation in a 10th patient. The significant difference in  $P_{\text{eff}}$  between baseline and follow-up may be explained by several factors. Firstly, although patients reported to have slept during predominant part of the titration period, this was not objectified. Therefore, it cannot be excluded that the 2h nap did not provide a sufficient time window to accurately titrate a  $P_{\text{eff}}$  that abolished all obstructed breathing events. Secondly, it could be argued that the relatively short sleeping period during Nap-titration does not allow for an adequate amount of REM sleep. It is commonly accepted that, as a result of greater upper airway collapsibility, REM sleep requires higher CPAP levels than non-REM sleep. As a resultant, a lower pressure may be titrated than truly is required. Consequently, obstructed breathing events may be eliminated during Nap-titration whereas not during a conventional night in the patient's home situation. However, recent studies with Auto-CPAP devices suggest that the highest CPAP levels may actually be required during stage 1 non-REM sleep.<sup>24</sup> Thirdly, the "end-point" of Nap-titration may also explain the discrepancy in  $P_{\text{eff}}$ . Although Nap-titration is aimed at eliminating snoring, flow limitations are probably a more sensitive marker of upper airway obstruction.<sup>25</sup> Therefore, a persistence in OSAHS symptomatology following Nap-titration may be explained by the fact that in some patients obstructed breathing events were not adequately eliminated. However, the need for elimination of airflow limitations in CPAP titration is still a controversial topic.<sup>26</sup> Potential improvements with the elimination of flow limitations should always be balanced by the

risk for pressure intolerance or increased mask leakage due to higher CPAP pressures. In conclusion, it appears that the origin for the observed discrepancy in  $P_{\text{eff}}$  between baseline and follow-up is multifactorial. Despite the significantly lower  $P_{\text{eff}}$  following Nap-titration, adequate CPAP titration was accomplished in 23 out of 24 patients by arbitrarily raising the pressure in the presence of persisting OSAHS symptomatology. The latter technique has also been employed by others and proven to be practical and efficacious.<sup>6,8</sup> Therefore, when the outcome of Nap-titration is verified by an adequate follow-up with pressure adjustments being performed when indicated, it may be considered an appropriate procedure.

Some methodological limitations may compromise the implications of the present study. Although standard guidelines have not been established and its reproducibility is not well known,<sup>27</sup> manual CPAP titration is considered the "reference standard" for CPAP titration. Because in our hospital polysomnography is conducted on an ambulatory basis, a comparative study on the precise relationship between Nap-titration and manual CPAP titration was not feasible. However, by defining successful titration as an  $\text{AHI} < 5$ , we conformed to a generally accepted criterion for optimal CPAP efficacy.<sup>28</sup> Therefore, despite the lack of manual titration as "reference standard", the present titration technique was contrasted to a valid standard. Secondly, pressure adjustments at the 2 week follow-up after Nap-titration were only guided by subjective criteria (i.e. OSAHS symptomatology) and not polysomnographic data. Therefore, there is a potential risk with the present titration protocol of titrating unnecessary high pressures than truly are required. With higher CPAP pressures the risk of pressure intolerance and nasal problems is more conceivable. However, problems that may result from higher CPAP pressures were not encountered in any of the subjects studied. In addition, as previously mentioned, pressures obtained at follow-up were comparable to pressures obtained in other studies with manual CPAP titration.<sup>5,17</sup> We therefore believe that the  $P_{\text{eff}}$  derived from Nap-titration with an adequate follow-up is not higher than truly is required. Finally, CPAP compliance was not objectified in the present study. Instead, patients were asked to report their compliance. It has been reported that self-reports are unable to distinguish between compliant and non-compliant patients.<sup>29</sup> However, other studies reported that, although patients may over-report their CPAP use by a small amount, there is a good correlation between self-reported and objectively measured CPAP compliance.<sup>30</sup> In the present study

the patient reported compliance was adequate with an average CPAP use of 6.9 days per week and 6.9 h per night, respectively. In addition, patients reported using CPAP for a minimum of 5 h per night, which may be considered satisfactory.<sup>31</sup> Moreover, contrary to the specific titration technique, evidence from systematic literature review suggests that an adequate education and support programme is more important to achieve favourable CPAP compliance when initiating therapy.<sup>31</sup> By employing skilled nursing consultants and an intensive follow-up regime the later provision was believed to be adequately met in the present study.

It is concluded that a CPAP pressure derived from Nap-titration with an adequate follow-up regime is efficacious in the management of OSAHS. This relatively novel procedure yields similar improvements in most objective and subjective outcomes when compared with other studies following manual CPAP titration. Despite the adequate titration of CPAP in all patients completing the study, pressure changes were required in a considerable proportion of patients following Nap-titration. The latter phenomenon appears to be related to multiple causes and stresses the necessity for an adequate follow-up after Nap-titration.

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