Clinical Outcomes Related to Interface Type in Patients With Obstructive Sleep Apnea/Hypopnea Syndrome Who Are Using Continuous Positive Airway Pressure*

Clifford A. Massie, PhD; and Robert W. Hart, MD, FCCP

**Study objectives:** To evaluate the effect of interface on objective compliance, patient satisfaction, adverse effects, quality of life, and residual sleep-disordered breathing in patients with obstructive sleep apnea/hypopnea syndrome (OSAHS) using continuous positive airway pressure (CPAP).

**Design:** Randomized, cross-over.

**Setting:** Two suburban community-based hospital sleep laboratories.

**Patients:** Data were collected on 39 patients with OSAHS (mean age, 48.7 years), in whom CPAP was a novel treatment.

**Interventions:** Interventions were nasal pillows (Breeze; Mallinckrodt Corporation; Minneapolis, MN) and nasal mask (Contour; Respironics; Murrysville, PA).

**Measurements and results:** Outcomes assessed at the completion of each 3-week treatment period were objective compliance, adverse effects, and satisfaction with CPAP (CPAP questionnaire), daytime sleepiness (Epworth sleepiness scale [ESS]), quality of life (Functional Outcomes of Sleep Questionnaire [FOSQ]), sleep diary, and residual sleep-disordered breathing (apnea-hypopnea index [AHI]). Patients were randomly assigned to use the nasal pillows or the nasal mask following laboratory titration and initiated on CPAP (pressure range, 5 to 14 cm H2O). The percentage of days utilized favored the nasal pillows (94.1% vs 85.7%; \( p = 0.02 \)), but minutes of use per night did not differ (nasal pillows, 223 min; nasal mask, 288 min). ESS scores were lower and the FOSQ total scores were higher following CPAP treatment (\( p < 0.001 \)), but no differential treatment effects were noted. Fewer adverse effects, less trouble getting to sleep and staying asleep, and less air leak were reported with nasal pillows (\( p < 0.04 \)). The mean ± SD pretreatment AHI (47.1 ± 35.1/h) was significantly lower following treatment with CPAP for both types of interface (nasal pillows, 10.2 ± 9.8/h; nasal mask, 7.0 ± 7.7/h; \( p < 0.001 \)).

**Conclusions:** Nasal pillows are a well-tolerated and effective interface for OSAHS patients receiving CPAP at ≤ 14 cm H2O. Use of nasal pillows was associated with fewer adverse effects and better sleep quality during the first 3 weeks of CPAP therapy. Further investigation is needed to determine whether interface type affects long-term CPAP use. (CHEST 2003; 123:1112–1118)

**Key words:** compliance; continuous positive airway pressure; interface; obstructive sleep apnea

**Abbreviations:** AHI = apnea-hypopnea index; CPAP = continuous positive airway pressure; EDS = excessive daytime sleepiness; ESS = Epworth sleepiness scale; FOSQ = Functional Outcomes of Sleep Questionnaire; OSAHS = obstructive sleep apnea/hypopnea syndrome; PER = percentage of days used; TOT = daily use for all days; UTL = daily use for days with use > 0 min; VAS = visual analog scale.

---

Continuous positive airway pressure (CPAP) is typically delivered via nasal mask to patients with obstructive sleep apnea/hypopnea syndrome (OSAHS), acting as a pressure splint to maintain upper airway patency. CPAP may also be delivered via nasal pillows or oronasal mask. Interface can have a significant impact on acceptance and adherence to CPAP therapy. Adverse effects such as claustrophobia and mask discomfort, air leak, pressure sores, and mask dislodgement compromise CPAP use.1–6 Nasal pillows offer potential advantages over the nasal mask. First, there is less contact with the face, which may attenuate the feeling of claustrophobia and help prevent pressure sores and minimize discomfort. Second, patients may perceive less air leak, as leak would occur away from the eyes. Third, the design of the headgear may enhance patient comfort and simplify use.

Proper mask fit is paramount. Patients usually receive their first exposure to interface in the laboratory setting, although acclimation and desensitiza-
tion may occur before the titration study in the context of the physician’s office. Laboratory titrations are often performed only with a nasal mask without patients being shown nasal pillows or given a choice. Nasal pillows may be reserved for patients who complain of claustrophobia, or who cannot otherwise tolerate the nasal mask, and are not used as first-line interface. Initial choice of interface may be particularly important since early experience with CPAP plays a role in long-term adherence to therapy.6–8

Mask discomfort has been included as an adverse effect on questionnaires assessing CPAP compliance, but interface type has rarely been the subject of systematic investigation. In a randomized cross-over trial comparing nasal mask with oronasal mask, patients reported fewer adverse effects while using the nasal mask and preferred this type of interface. The oronasal mask may be too uncomfortable for long-term use, even with the addition of heated humidification to decrease airway dryness and reduce mouth leak.10 The present study compared the nasal pillows and nasal mask on objective compliance, adverse effects, satisfaction with therapy, quality of life, and residual sleep-disordered breathing in OSAHS patients receiving CPAP.

MATERIALS AND METHODS

Subjects

Eligible patients were between 18 years and 70 years of age, had an OSAHS diagnosis (apnea-hypopnea index [AHI] ≥ 15/h or AHI ≥ 5 plus daytime sleepiness),11 and had not received CPAP treatment previously. Exclusion criteria included wake resting arterial oxygen saturation < 90%, evidence of upper airway tract infection or flu-like symptoms at the time of titration, elective surgery scheduled before conclusion of the study, or prior surgical intervention for OSAHS. Patients were not eligible if they required bilevel positive airway pressure or supplemental oxygen.

At the time of initial polysomnography, patients gave consent. Participants agreed to use CPAP for the duration of the 6-week study and to provide feedback on the interface and satisfaction with CPAP therapy. Patients were not informed that the study was designed to assess compliance, but they were debriefed at the conclusion of the study regarding compliance monitoring. Institutional review board approval was obtained from the two hospital-based sleep laboratories; the consent forms were identical.

Questionnaires

Patients completed the Functional Outcomes of Sleep Questionnaire (FOSQ) prior to initiating CPAP therapy and at the end of each treatment period. The FOSQ is a quality-of-life instrument designed to assess the impact of excessive daytime sleepiness (EDS) on activities of daily living.12 The FOSQ provides a global score and five scales: general productivity, social outcome, activity level, vigilance, and intimate relationships and sexual activity. Patients also completed the Epworth sleepiness scale (ESS).13

At each assessment interval, patients completed the FOSQ, ESS, and a questionnaire designed to assess adverse effects and satisfaction with CPAP therapy (Table 1). Patients maintained a sleep diary for the first week of each treatment, and rated adverse effects and sleep quality using a visual analog scale (VAS). Diary questions included the following: How well did your mask fit? (very badly—very well); How much trouble did you have putting on the mask? (severe trouble—no trouble); Did you have air leaking from the mask? (much air leaking—no air leaking); Did you have trouble keeping the mask in place? (severe trouble—no trouble); How restful was your sleep? (very restless—very restful); How refreshed did you feel this morning? (exhausted—very refreshed); How much discomfort did you get from the pressure? (severe discomfort—no discomfort); and Did you have a dry or congested nose or throat? (much dryness—no dryness). For all VAS questions, higher numbers indicated a more positive response.

Study Design

A randomized cross-over design was employed. Patients were assigned to nasal pillows (Breeze; Mallinckrodt Corporation; Minneapolis, MN) or nasal mask (Contour; Respironics; Murrysville, PA). CPAP titration was performed in the laboratory with the appropriate interface and heated humidity (HC100 humidifier; Fisher & Paykel; Auckland, New Zealand). Each patient underwent either all-night CPAP titration or a split-night study according to American Academy of Sleep Medicine standards.14 Titration protocols were identical at both sites. Effective pressure was attained when evidence of apneas, hypopneas, snoring, and hypoxemia were ameliorated. CPAP was prescribed after the polysomnogram was reviewed by a board-certified sleep specialist.

Interface fitting was performed according to the written instructions of the manufacturers. A registered polysomnographic technologist and board-certified sleep specialist reviewed written instructions with each technician. Hands-on fitting was performed, and each technician was given feedback and checked for accuracy. The nasal pillows were fitted using the side straps. The cradle was fit just below the curve at the back of the head. Adjustments were made to the height of the cradle, length of the hose guide across the top of the head, and height of the plenum.
Table 1—CPAP Questionnaire

Below is a list of problems people may experience when using CPAP. Please go through the list and mark down how frequently you experienced each problem during the past 3 weeks. If you have a problem that is not included on this list, please explain at the bottom of this page. The choices are as follows: (0) not a problem, (1) a slight problem, (2) a moderate problem, and (3) a major problem.

<table>
<thead>
<tr>
<th>Problems</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pressure from the mask</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>2. Skin irritation from the mask</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>3. Mask coming off the face</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>4. Air leaks from the mask</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>5. Putting on the mask</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>6. Claustrophobia from the mask</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>7. Machine noise</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>8. Dry mouth or throat</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>9. Dry or congested nose</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>10. Headache</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>11. Difficulty breathing</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>12. Chest discomfort</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

The following questions* relate to CPAP use during the past 3 weeks:

13. How satisfied were you with CPAP?
14. How satisfied were you with the mask?
15. How refreshed did you feel after waking in the morning?
16. How restful was your sleep?
17. How much trouble did you have getting to sleep?
18. How much trouble did you have staying asleep during the night?

*Questions 13–18 rated on a 100-mm VAS. Measures range from 0 (poorest) to 100 (highest possible rating).

Statistical Analyses

Values are given as mean ± SD. Comparisons between baseline and treatment conditions were conducted using one-way analysis of variance. Interface comparisons were conducted using paired t tests or, in the case of nonnormally distributed data, Wilcoxon signed-rank tests. Unless otherwise indicated, statistical significance required p ≤ 0.05, two-tailed.

Results

Patient Characteristics

Forty-two patients were enrolled in the study. Three patients were unable to complete the protocol. One patient traveled to Europe and was unable to use the equipment. An unrelated medical condition developed in one patient; he was dropped from the study but maintained on CPAP treatment. One patient was unavailable for follow-up.

Thirty-nine patients completed the 6-week protocol. Twenty-four patients underwent full-night CPAP titrations, and 15 patients underwent split-night studies. Twenty patients were randomized to the nasal pillows, and the remaining 19 patients were randomized to the nasal mask. There were no differences between randomized groups in age, gender, study type, body mass index, AHI, or CPAP pressure (all p values ≥ 0.18; Table 2). Differences were noted only for age, gender, and study type between the two sleep laboratories (p values ≤ 0.05).
Compliance

Three compliance indexes were calculated: percentage of days used (PER), mean daily use for all days (TOT), and mean daily use for days with use > 0 min (UTL). A significant difference was observed between the nasal pillows (94.1 ± 8.3%) and the nasal mask (85.7 ± 23.5%) on PER (p = 0.02). No differences were noted between nasal pillows and nasal mask on TOT or UTL (p values ≥ 0.10; Table 3). CPAP use ranged from 184 to 456 min per night with nasal pillows and from 22 to 463 min per night with the nasal mask.

Residual Sleep-Disordered Breathing

Mean AHI was calculated for each of the treatment periods, where daily use was > 0 min. A significant main effect for AHI was observed (F2,37 = 38.8; p < 0.001). Residual sleep-disordered breathing did not differ between the two types of interface (p = 0.83). These data are presented in Table 3.

Daytime Sleepiness

A significant main effect for daytime sleepiness was observed (F2,37 = 30.6; p < 1). ESS scores were lower following 3 weeks of CPAP treatment, but no difference in ESS scores were observed between the two types of interface (p = 0.84).

Sleep Diary

Patients maintained a sleep diary daily for the first week of each treatment. Mean values were calculated for each of the eight items. Patients reported less air leak with the nasal pillows (p = 0.008). No other differences were observed.

Quality of Life

A significant main effect for total FOSQ score was observed (F2,37 = 20.9; p < 0.001). Significant main effects were noted for the following individual scales: vigilance (F2,37 = 15.5; p < 0.001), activity level (F2,37 = 11.7; p < 0.001), social outcome (F2,37 = 6.2; p = 0.003), and general productivity (F2,37 = 13.5; p < 0.001). The interpersonal and sexual relationships scale did not differ between baseline and treatment. No differences were noted between the nasal pillows and nasal mask on FOSQ total score or any of the individual scales (all p values ≥ 0.83).

CPAP Questionnaire

At the conclusion of each treatment period, adverse effects and satisfaction with CPAP were assessed and a global score calculated by summing questions 1 to 12. Nasal pillows was associated with fewer overall adverse effects (t = 3.8; p < 0.001). Individual-item analysis revealed significant differences for all questions pertaining to the interface (questions 1 to 6). Patients reported a greater degree of overall satisfaction with nasal pillows (p = 0.001) and less trouble getting to sleep and staying asleep (p values ≤ 0.04). Comparisons for questions 13 to 18 of the CPAP questionnaire are presented in Table 4.

Discussion

This is the first report of CPAP use, adverse effects, and residual sleep-disordered breathing with nasal pillows, when compared to nasal mask. Fewer overall adverse effects, including less air leak and better self-reported sleep quality, were reported.

Table 2—Demographic and PolySomnography Variables for 39 Patients Randomized to Nasal Pillows or Nasal Mask on Titration and Initial Treatment*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nasal Pillows</th>
<th>Nasal Mask</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 20)</td>
<td>(n = 19)</td>
<td>(n = 39)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>18</td>
<td>14</td>
<td>32†</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>5</td>
<td>7†</td>
</tr>
<tr>
<td>Study type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full night</td>
<td>11</td>
<td>13</td>
<td>24†</td>
</tr>
<tr>
<td>Split night</td>
<td>9</td>
<td>6</td>
<td>15†</td>
</tr>
<tr>
<td>Age, yr</td>
<td>47.7 ± 8.9</td>
<td>49.8 ± 8.2</td>
<td>48.7 ± 8.5</td>
</tr>
<tr>
<td>Body mass index</td>
<td>36.3 ± 6.8</td>
<td>35.5 ± 6.0</td>
<td>35.9 ± 6.4</td>
</tr>
<tr>
<td>AHI, events/h</td>
<td>48.6 ± 36.9</td>
<td>45.5 ± 34.0</td>
<td>47.1 ± 35.1</td>
</tr>
<tr>
<td>CPAP pressure, cm H2O</td>
<td>8.9 ± 2.4</td>
<td>8.4 ± 2.0</td>
<td>8.6 ± 2.2</td>
</tr>
</tbody>
</table>

*Data are expressed as No. or mean ± SD.
†χ2 analysis.

Table 3—Differences in Outcome Measures Between Nasal Pillows and Nasal Mask*

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Pretreatment</th>
<th>Nasal Pillows</th>
<th>Nasal Mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>PER</td>
<td>94.1 ± 8.3</td>
<td>85.7 ± 23.5†</td>
<td></td>
</tr>
<tr>
<td>TOT, min</td>
<td>322.6 ± 85.7</td>
<td>288.4 ± 113.1</td>
<td></td>
</tr>
<tr>
<td>per night total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UTL, min</td>
<td>336.7 ± 77.4</td>
<td>322.6 ± 93.2</td>
<td></td>
</tr>
<tr>
<td>per night used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHI, events/h</td>
<td>47.3 ± 35.4</td>
<td>10.2 ± 9.8</td>
<td>7.0 ± 7.7†</td>
</tr>
<tr>
<td>ESS</td>
<td>12.8 ± 4.9</td>
<td>5.9 ± 3.4</td>
<td>6.4 ± 3.8†</td>
</tr>
<tr>
<td>FOSQ, total score</td>
<td>15.5 ± 2.4</td>
<td>18.1 ± 1.5</td>
<td>18.1 ± 1.6†</td>
</tr>
</tbody>
</table>

*Data are presented as mean ± SD.
†p < 0.05.
‡Results are significantly different from baseline (p < 0.001).
when CPAP was used with nasal pillows. Attempted CPAP use during the first 3 weeks of therapy favored nasal pillows, but use per night did not differ between the two types of interface. The greater attempt at CPAP use with nasal pillows was likely due to self-report of better sleep quality, fewer adverse effects, and greater satisfaction with this type of interface.

Adverse effects related to interface are common and may compromise CPAP use. Pressure sores, mask dislodgement, feeling claustrophobic, air leak, and sore eyes occur in 20 to 50% of OSAHS patients receiving CPAP. Self-report of air leak and sore eyes correlate negatively with CPAP use. Conversely, increased CPAP use is related to good or very good tolerance to the nasal mask. Nearly 50% of patients who reported CPAP use ≥ 4 h per night had good or very good tolerance to the nasal mask, whereas only 9% of patients with use < 4 h per night reported good tolerance. Patients whose objective leak was not monitored by the CPAP machine concerning the nature of the mask seal and the possibility of inadequate pressure delivery. Objective leak was not monitored by the CPAP machine used in this study. Consequently, the patient’s report of less air leak could not be compared to quantitative data. Prior research indicates that mask leak has minimal effect on AHI. During 2 months of fixed-pressure CPAP use, no correlation between mask leak and AHI was reported. Leak values varied from patient to patient and from night to night, but even periods of high leak had a negligible impact on AHI.

<table>
<thead>
<tr>
<th>Item</th>
<th>Nasal</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>How satisfied were you with CPAP?</td>
<td>74 ± 20</td>
<td>66 ± 24</td>
</tr>
<tr>
<td>How satisfied were you with the mask?</td>
<td>65 ± 27</td>
<td>43 ± 281</td>
</tr>
<tr>
<td>How refreshed did you feel after waking in the morning?</td>
<td>68 ± 21</td>
<td>60 ± 21</td>
</tr>
<tr>
<td>How restful was your sleep?</td>
<td>69 ± 22</td>
<td>63 ± 21</td>
</tr>
<tr>
<td>How much trouble did you have getting to sleep?</td>
<td>77 ± 18</td>
<td>71 ± 264</td>
</tr>
<tr>
<td>How much trouble did you have staying asleep during the night?</td>
<td>69 ± 22</td>
<td>57 ± 264</td>
</tr>
</tbody>
</table>

*Data are expressed as mean ± SD. Measures range from 0 (poorest) to 100 (highest possible rating).

The goal of laboratory titration is to eliminate sleep-disordered breathing. Residual sleep-disordered breathing was acceptably low for both types of interface, and comparable to previous CPAP efficacy studies. ESS and FOSQ scores were improved from pretreatment values for both types of interface, indicating that the reduction in AHI was sufficient to attenuate the daytime consequences of OSAHS. Several studies have demonstrated reductions in EDS and improvements in quality of life following CPAP treatment.

The equivalent reduction in AHI observed with both types of interface is a noteworthy finding. Nasal pillows may not be considered for patients who require higher CPAP pressure levels because of concerns regarding the nature of the mask seal and the possibility of inadequate pressure delivery. Objective leak was not monitored by the CPAP machine used in this study. Consequently, the patient’s report of less air leak could not be compared to quantitative data. Prior research indicates that mask leak has minimal effect on AHI. During 2 months of fixed-pressure CPAP use, no correlation between mask leak and AHI was reported. Leak values varied from patient to patient and from night to night, but even periods of high leak had a negligible impact on AHI. In this study, CPAP pressure range was 5 to 14 cm H2O. All patients randomized to nasal pillows were successfully titrated in the laboratory. Prior investigations report effective CPAP pressure levels in the range of 8 to 13 cm H2O, with SDs of approximately 2 to 3 cm H2O. A broad range of OSAHS severity was represented in these studies, including patients with moderate-to-severe disease. Nasal pillows should be considered for initial laboratory titration, rather than being reserved for patients who cannot tolerate nasal masks.

Compliance with CPAP is well recognized to be less than optimal. Interventions that increase CPAP compliance include the addition of heated humidification, intensive support/education, and autotitrating CPAP. Heated humidity was supplied to all patients in this study. Patients were told not to make any changes to the humidifier setting if they felt comfortable. If water
droplets appeared in the mask, patients were told to
decrease the setting by 0.5 U until condensation no
longer appeared. Many patients needed to lower the
setting on the humidifier when using the nasal pillows
because of condensation in the tubing and mask. It is
not clear why this occurred, but suggests that adverse
effects associated with nasal airway resistance may be
attenuated with lower humidity settings. Patients were
monitored closely during this study and provided with
extensive education regarding OSAHS and CPAP use.
Demand characteristics do not appear to have influ-
enced compliance; CPAP use during this study was in
the range of 5 h per night, similar to other studies that
coveted monitored compliance early in therapy.7,29,30

A challenge to performing this type of study was
choosing a “standard” nasal mask. The nasal mask
chosen for this study is widely available and used
frequently in laboratory and clinical settings. How-
ever, interface has changed considerably over the
years; newer types of interface are designed to be
more comfortable and to attenuate discomfort
caused by improper fit, including skin abrasion and
air leak. It is possible that fewer differences in
adverse effects and attempt at use would have
occurred with a newer generation nasal mask.
Another limitation is the relatively short assessment
interval. While the goal was to determine whether
differences in CPAP use as a function of interface
occurred early in treatment, no long-term follow-up
of these patients was conducted. At the conclusion of
the 3-week study, patients kept both types of inter-
face. Many patients chose to use the nasal pillows as
the primary interface, but also expressed an inten-
tion to alternate interface use. It is important that
interface be matched to individual patient needs and
that patients be followed up closely to assess their
clinical response to therapy. Minimizing adverse
effects related to interface early in therapy may
result in greater acceptance of long-term CPAP use.

In summary, this study confirms our clinical im-
pression that patients feel less claustrophobic and
report less discomfort with use of nasal pillows.
Fewer adverse effects and improved self-reported
sleep quality with nasal pillows use were observed.
This may have accounted for the greater attempt at
CPAP use during the first 3 weeks of therapy.
Improvements in quality of life and reductions in
AHI and EDS were noted for both types of inter-
face. Nasal pillows are an effective and well-tolerated
interface for patients with OSAHS receiving CPAP
at ≤14 cm H₂O.

REFERENCES
1 Sanders MH, Gruendl CA, Rogers RM. Patient compliance
with nasal CPAP therapy for sleep apnea. Chest 1996;
90:330–333
continuous positive airway pressure in sleep apnea syndrome.
Chest 1995;107:375–381
3 Kalan A, Kenyon GS, Seemungal TAR, et al. Adverse effects
of nasal continuous positive airway pressure therapy in sleep
apnoea syndrome. J Laryngol Otol 1999;113:888–892
Self-reported use of CPAP, and benefits of CPAP therapy.
Chest 1996;109:1470–1476
5 Janson C, Noges E, Svedberg-Brandt S, et al. What charac-
terizes patients who are unable to tolerate continuous positive
airway pressure (CPAP) treatment? Respir Med 2000;94:
145–149
6 Kribs NB, Pack AI, Kline LR, et al. Objective measurement
of patterns of nasal CPAP use by patients with obstructive
7 Weaver TE, Kribs NB, Pack AI, et al. Night-to-night
variability in CPAP use over the first three months of
treatment. Sleep 1997;20:278–283
8 McArule N, Devereux G, Heidarnajad H, et al. Long-term
use of CPAP therapy for sleep apnea/hypopnea syndrome.
Am J Respir Crit Care Med 1999;159:1108–1114
9 Mortimore HL, Whittle AT, Douglas NJ. Comparison of nose
and face mask CPAP therapy for sleep apnea. Thorax 1998;
53:290–292
10 Martins De Araujo MT, Vieira SB, Vasquez EC, et al. Heated
humidification or face mask to prevent upper airway dryness
during continuous positive airway pressure therapy. Chest
2000;117:142–147
11 American Academy of Sleep Medicine Task Force. Sleep-
related breathing disorders in adults: recommendations for
syndrome definition and measurement techniques in clinical
12 Weaver TE, Laizner AM, Evans LK, et al. An instrument to
measure functional status outcomes for disorders of excessive
sleepiness. Sleep 1997;20:833–843
13 Johns MW. A new method for measuring daytime sleepiness:
the Epworth Sleepiness Scale. Sleep 1991;14:540–545
14 American Sleep Disorders Association Report. Practice pa-
rameters for the indications for polysomnography and related
procedures. Sleep 1997;20:406–422
15 Raunder H, Formanek D, Popp W, et al. Self-reported vs
measured compliance with nasal CPAP for obstructive sleep
apnea. Chest 1993;103:1675–1680
survey of 3,225 patients treated with CPAP for obstructive
sleep apnoea: benefits, tolerance, compliance and quality of
17 Looker JS, Ancoli-Israel S, Dimsdale JE. Effect of continuous
positive airway pressure vs placebo continuous positive airway
pressure on sleep quality in obstructive sleep apnea. Chest
1999;116:1545–1549
airway pressure requirement during the first month of treat-
ment in patients with severe obstructive sleep apnea. Chest
1998;114:1061–1069
19 D’Ambrosio G, Bowman T, Molsenin V. Quality of life in
patients with obstructive sleep apnea: effect of nasal contin-
uous positive airway pressure; a prospective study. Chest
1999;115:123–129


28 Hudgel DW, Fung C. A long-term randomized, cross-over comparison of auto-titrating and standard nasal continuous airway pressure. Sleep 2000; 23:645–648
