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Determinants of compliance with nasal continuous positive airway pressure treatment applied in a community setting

E.M. Ball[a,*], M.B. Banks[b]

[a]*Department of Internal Medicine, Walla Walla Clinic, 55 West Tietan, Walla Walla, WA 99362, USA*
[b]*Walla Walla Home Medical, Walla Walla, WA 99362, USA*

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Abstract

Objectives: To assess determinants of nasal continuous positive airway pressure (CPAP) compliance when applied in a community setting.

Background: One-third of obstructive sleep apnea patients eventually refuse CPAP therapy. Treatment outcomes may be improved by identifying predictors of CPAP failure, including whether management by primary care physicians without sleep consultation affects results.

Methods: Polysomnogram, chart review, and questionnaire results for regular CPAP users ($n = 123$) were compared with those returning the CPAP machine ($n = 26$).

Results: Polysomnographic data and the presence of multiple sleep disorders were only modestly predictive of CPAP compliance. Striking differences in questionnaire responses separated CPAP users from non-users, who reported less satisfaction with all phases of their diagnosis and management. Rates of CPAP use were not significantly different between patients managed solely by their primary care physician or by a sleep consultant.

Conclusions: Polysomnographic findings are unlikely to identify eventual CPAP non-compliers in a cost-effective fashion. Improvements in sleep apnea management may result from addressing the role of personality factors and multiple sleep disorders in determining compliance. In this practice setting, management by primary care physicians did not significantly degrade CPAP compliance.

Keywords: Determinants of compliance; Nasal continuous positive airway pressure treatment; Community setting

1. Introduction

Although nasal continuous positive airway pressure (CPAP) is the treatment of choice for most patients with obstructive sleep apnea (OSA) [1–3], compliance is problematic, with 2–36% of patients refusing to try CPAP at home and 6–35% discontinuing treatment after a period of home use [4–8]. On average, one-third of patients subjected to the expense of diagnostic polysomnography, CPAP titration, and/or purchase of the machine will decline CPAP treatment. Given the estimated prevalence of OSA syndrome in the United States (7–18 million patients [9]), and assuming an average expenditure of $2500 per patient, CPAP returns represent up to 15 billion dollars worth of wasted health care resources.

In addition, as cost-containment pressures from insurers build, primary care physicians may be increasingly asked to manage sleep-disordered patients.

* Corresponding author. Tel.: +1-509-525-3720; fax: +1-509-525-1588.
E-mail address: balle@bmi.net (E.M. Ball).

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Long-term CPAP compliance will be one measure of the effectiveness of these providers in managing OSA patients.

A major goal in the management of OSA is to determine whether CPAP compliance can be predicted prospectively, such that patients less likely to comply might be offered more intensive reinforcement programs or different treatment algorithms. This paper presents data from the Walla Walla Project, a community physician-based program of sleep disorders evaluation and treatment, to assess determinants of CPAP compliance, including whether management by primary care physicians in comparison to experienced sleep clinicians affects the outcome.

2. Materials and methods

The details of the Walla Walla Project have been described elsewhere [10]. During the first 2 years of the project, 16 channel polysomnograms (PSGs) were obtained locally on computerized equipment with removable hard drive discs. The discs were then sent to Dr German Nino-Murcia's laboratory where all studies were hand scored in standard fashion [11–15]. The scored study was then interpreted by a local physician. Two internists obtained additional sleep disorders education, and developed into local sleep consultants [10] (one of whom has now become certified by the American Board of Sleep Medicine). Patients undergoing CPAP titration were therefore from one of three groups: primary care patients of the two sleep-interested internists, patients from other physicians who were referred for sleep consultation, or patients of other physicians whose sleep disorder was managed by that physician without consultation.

2.1. Outcome assessment

In addition to the PSG data before and after CPAP treatment, all 228 patients completing CPAP titration during the first 2 years of the Walla Walla Project (February 1992 to February 1994) were mailed a questionnaire (in December 1994) 10–32 months after their CPAP titration, in which patients rated themselves as either using, not using, or having returned the CPAP machine (this status was also verified by records of the area's main home medical supplier). This paper will compare the characteristics of two groups: CPAP users and patients who returned their machine.

The questionnaire also contained 18 questions in four subject groups: satisfaction with the CPAP equipment (such as the mask, tubing, humidifier, etc.); the testing process; the degree to which the patient felt informed about his/her condition; and the severity of sleep apnea symptoms (see Appendix A). All items were rated on a 100 mm visual analog scale; responses were averaged for each of the four question groups.

The charts of all study subjects were reviewed in 1995, 1–3 years after the initial PSG, to determine the final sleep disorder diagnosis(es), and the presence of certain co-morbid conditions (such as hypertension and coronary artery disease). A final sleep disorder diagnosis was defined as a condition significant enough to warrant attempts at treatment. The chart review also determined the physician responsible for the management of the sleep disorder, and whether sleep consultation occurred.

For all analyses of the PSG data, patients undergoing split-night studies were excluded because the PSG data averaged both parts of the test, and are not comparable with a full night diagnostic or CPAP study. Split-night patients (31 users, two returns) are included in all other analyses (questionnaire, chart review, and physician management). For this analysis, only periodic leg movements in sleep (PLMS) with associated arousal are considered. Full details of PSG scoring are presented elsewhere [10].

2.2. Statistical analysis

The data were analyzed using Statistica® (StatSoft, Tulsa, OK) software. Group means (see Tables 1–4) were compared using *t*-tests for independent samples, and rates of CPAP machine use or return with differing physicians' management were compared using the χ^2 statistic (Table 4). Forward stepwise discriminant function analysis was employed in each data group (Tables 1–3) to determine which variables contained independent predictive value, and to assess the relative power (expressed as the overall multivariate *F* statistic) of the model developed for each data group [16].

3. Results

During the first 2 years of the Walla Walla Project, a

Table 1
CPAP use and PSG variables (excludes split-night studies)[a]

Item	User (±SD)	Returned (±SD)	*P* Value
n	92	24	
Male (%)	70.6	66.7	0.71
Age (years)	56.0 (13.4)	60.0 (18.2)	0.24
Body mass index	33.9 (9.4)	31.7 (6.7)	0.29
RDI			
Pre	41.5 (30.2)	31.3 (20.6)	0.12
Post	10.6 (8.6)	14.1 (15.7)	0.15
Change	−30.9 (28.1)	−17.2 (19.1)	0.026*
AI			
Pre	21.7 (24.0)	13.0 (11.1)	0.09
Post	2.3 (4.2)	4.2 (10.4)	0.17
Change	−19.4 (23.2)	−8.9 (11.1)	0.033*
Nadir SaO_2			
Pre	79.3 (8.2)	81.7 (8.4)	0.21
Post	87.3 (4.5)	86.5 (4.9)	0.40
Change	+8.0 (7.0)	+4.8 (7.0)	0.045*
Delta (%)			
Pre	14.2 (9.4)	17.1 (10.9)	0.18
Post	18.5 (11.0)	19.8 (13.0)	0.61
Change	+4.3 (12.5)	+2.7 (12.9)	0.57
REM (%)			
Pre	14.6 (7.4)	14.0 (7.1)	0.72
Post	16.9 (8.4)	14.1 (7.1)	0.14
Change	+2.2 (10.6)	+0.3 (7.5)	0.42
Arousal (#)			
Pre	16.5 (18.6)	25.6 (29.2)	0.064
Post	22.5 (16.4)	15.5 (12.0)	0.052
Change	+6.0 (22.2)	−10.1 (24.6)	0.003*
PLMS (#)			
Pre	11.9 (21.3)	32.7 (49.0)	0.002*
Post	20.5 (40.0)	25.4 (29.5)	0.058
Change	+8.6 (32.5)	−7.3 (47.9)	0.057
Sleep efficiency (%)			
Pre	76.2 (13.4)	75.0 (16.6)	0.72
Post	76.6 (14.7)	72.2 (20.4)	0.23
Change	+0.4 (14.4)	−2.8 (16.8)	0.34
Pressure (cmH_2O)	9.8 (3.7)	9.3 (2.1)	0.49

[a] Polysomnographic findings in CPAP users and those who returned their machine. Data before and after CPAP titration are designated by 'pre' and 'post', respectively. An asterisk (*) denotes $P < 0.05$.

total of 228 patients underwent CPAP titration for a sleep-related breathing disorder. Of these, 168 (76%; excludes seven patients who died and one patient who did not try CPAP at home) responded to a mailed questionnaire and reported either continued use ($n = 123$) or return ($n = 26$) of the CPAP machine; the remainder were not regularly using but had not returned the machine ($n = 19$). The 168 questionnaire responders did not differ statistically from questionnaire non-responders by demographic, PSG, or chart review data except for being older (57.0 vs. 50.8 years, $P = 0.022$), and more likely to have a final diagnosis of PLMS (17.9 vs. 5.7% with this diagnosis, $P = 0.03$).

CPAP users reported using their machine an average of 6.9 (±1.63 SD) h per night on 6.6 (±1.03 SD) nights per week. They estimated an average use of CPAP for 86.4% of their sleep hours over a duration of 21 months.

Table 1 lists the PSG findings (excluding split-night studies) before and after treatment in those patients who were using or had returned their CPAP equipment. CPAP users exhibited significantly greater improvements in some measures of OSA severity: respiratory disturbance index (RDI, number of apneas + hypopneas per hour of sleep), apnea index (AI, number of apneas per hour of sleep), and nadir of oxygen saturation (SaO_2). The number of unassociated arousals and PLMS increased with treatment in CPAP users, albeit each from a lower baseline than non-users. None of the diagnostic (pre-CPAP) PSG variables, except the number of PLMS, were significantly different between user groups.

Table 2 demonstrates that the presence of disordered sleep hygiene in addition to OSA significantly reduced

Table 2
CPAP use and final diagnosis/co-morbid conditions[a]

Disorder/condition	% User	% Returned	*P* Value
OSA	97.6	96.2	0.69
Upper airway resistance syndrome	2.4	3.8	0.88
PLMS	15.4	30.8	0.07
Insomnia	2.4	0	–
Sleep hygiene disorder	3.3	15.4	0.01
Circadian rhythm disorder	2.6	3.9	0.47
Hypertension	43.9	26.9	0.11
Coronary artery disease	6.5	11.5	0.38
Nocturnal gastroesophagael reflux	14.6	26.9	0.13
Stroke	2.4	0	–
Motor vehicle accident	3.3	3.9	0.88
Thyroid hormone treatment	13.0	19.2	0.41

[a] Use ($n = 123$) or return ($n = 26$) of the CPAP machine in comparison to the patient's final sleep diagnosis, and the presence of selected co-morbid medical conditions. Patients with more than one diagnosis account for the total in excess of 100%.

Table 3
CPAP use and questionnaire responses[a]

Topic	User	Returned	*P* Value
CPAP equipment satisfaction	70.8	19.0	0.0001
PSG testing	80.3	66.9	0.0002
OSA symptoms/improvement	75.9	38.3	0.0001
Patient education	77.3	61.6	0.0019

[a] Use or return of the CPAP machine according to results of a mailed questionnaire. Responses to 18 questions are grouped into four subject areas: satisfaction with the home use of CPAP equipment (seven items); satisfaction with the process of polysomnographic testing and CPAP set-up (five items); degree of symptomatic impairment before, and improvement after, CPAP treatment (three items); and the degree to which the patient felt informed about his/her condition (three items). Ratings are based on a visual analog scale of 0–100 mm, in which higher numbers indicate greater satisfaction (or degree of impairment before, and improvement after, CPAP therapy).

the likelihood of CPAP compliance ($P = 0.01$). A diagnosis of PLMS was marginally non-significant ($P = 0.066$) in reducing CPAP compliance. Co-morbid conditions (hypertension, coronary artery disease, etc.) did not differ significantly among users and those who returned their machine.

When patients were questioned about their satisfaction with CPAP treatment, including OSA symptoms, sleep disorders education, PSG testing and CPAP equipment (Table 3), highly significant differences emerged, with non-compliant patients expressing more dissatisfaction with all aspects of their evaluation and treatment than CPAP users.

Finally, differences in CPAP compliance depending on whether the patient's sleep disorder was managed by a physician with significant sleep expertise or the patient's usual physician without formal sleep specialty consultation are shown in Table 4. Patients managed by their primary physician without consultation tended to have more severe disease by PSG criteria and slightly lower rates of CPAP use, although none of the differences in the rates of CPAP use reached statistical significance.

Each data group (Tables 1–3) was subjected to discriminant function analysis in a linear model of CPAP use. For PSG data (Table 1), six variables combined to predict compliance with an overall multivariate F statistic of 3.7 (higher values indicate stronger predictive power) ($P < 0.002$). The predictive variables were: pre-CPAP REM (%) and PLMS (number); post-CPAP RDI and delta sleep (%); and change in AI and number of arousals. In the model for final diagnoses and co-morbid conditions (Table 2), a diagnosis of a sleep hygiene disorder or PLMS, and the presence of hypertension were significant predictors (multivariate $F = 4.0$, $P < 0.01$). For questionnaire data (Table 3), the model's discrimination between groups was highly significant (multivariate $F = 45.0$, $P < 0.001$), with questions on equipment, symptoms, and the patient's sense of being informed being powerful predictors of CPAP use.

Table 4
CPAP use and sleep consultation[a]

Physician	*n*	% User	% Returned	Diagnostic PSG data[b]					
				RDI	AI	Delta (%)	REM (%)	Nadir SaO_2	PLMS (#)
Sleep MD Pt	93	56	11	36.3	16.8	17.4	13.4	80.4	14.0
Sleep Consult	70	57	11	35.1	18.5	14.7	16.2	79.8	15.2
Primary MD	65	49	12	48.4	26.9	13.3	13.7	76.9	14.0

[a] Use or return of the CPAP machine in comparison to whether the patient's sleep apnea was managed by one of two community sleep-interested internists as either their own primary care patient (Sleep MD Pt), or as a sleep consultation from another local physician (Sleep Consult), or by the patient's usual primary care physician without consultation (Primary MD). Data from all 228 CPAP-treated patients are presented. When questionnaire non-responders are excluded from the denominator, the percentage of CPAP users is 73, 71 and 67%, respectively.

[b] Data from the diagnostic PSG study for each group are shown, excluding split-night patients. Significant differences ($P < 0.05$) exist for % REM sleep (Sleep MD Pt vs. Sleep Consult), RDI, AI, Nadir SaO_2, % delta sleep (Sleep MD Pt vs. Primary MD), and RDI (Sleep Consult vs. Primary MD).

4. Discussion

Our results support the conclusion that polysomnography has a limited role in the prediction of CPAP compliance. In this study, while eventual CPAP users tended to have more severe disease and experience more improvement in PSG parameters with treatment, the differences were not marked, and most of the significant differences emerged only after a second study (CPAP titration) was performed, which would be too late for use in a cost-containment strategy.

The most significant differences in any of the outcome measures of this study were in the questionnaire data. Patients returning their machine were substantially more dissatisfied with every aspect of their management than CPAP users. The magnitude of the differences between user groups was striking regardless of whether the analysis was done by *t*-test or by discriminant function.

It seems unlikely that non-compliant patients were singled out in advance by everyone from their physicians and the technicians to the home medical supplier to receive reduced service or substandard equipment, and raises the possibility that personality factors are involved. The role of personality factors in determining CPAP compliance has been suggested by others [17,18], including one study in which the Minnesota Multiphasic Personality Inventory (MMPI) depression and hypochondriasis scales demonstrated predictive capacity [17]. Given our study's retrospective design, it is impossible to exclude the possibility that patients who fail to perceive a benefit from CPAP treatment could subsequently develop negative feelings towards the process. However, it seems unlikely that the effect of a failed treatment could have so tainted the patient's perspective as to produce results as dramatic and consistent as those we have observed.

Two findings from this study have not been previously described in the literature. First, our data suggest that the presence of more than one sleep disorder may affect compliance with CPAP therapy. Patients with a sleep hygiene disorder (and possibly PLMS) in addition to their OSA had reduced compliance. That the presence of sleep disorders other than OSA might affect the treatment of OSA seems biologically plausible, since these conditions might contribute to the patient's symptom burden, reducing the proportion of symptoms resulting from sleep apnea. In a recent study of patients complaining of persistent daytime sleepiness despite treatment for OSA, 43% (88/207) had significant PLMS [19]. Alternatively, sleep hygiene disorders may be an indicator of individuals with other personality or lifestyle features that impair compliance.

Second, we report the first comparison of CPAP compliance rates between patients managed by their primary care physician and those managed by sleep specialists. Overall, compliance of the 228 patients receiving CPAP treatment administered in this community setting was comparable to that reported in the literature [10]. When compliance rates in patients referred for sleep consultation or diagnosed from the primary care practices of the sleep specialists were compared with patients managed exclusively by their usual primary care physician, there was no significant difference. However, patients managed by their usual physician had more severe disease, which might have been expected to improve compliance somewhat (see Table 1).

It is not possible to conclude from these findings which management strategy is superior because patients were not randomly assigned and selection bias may have been present. Moreover, sleep specialists likely did influence management of those patients treated by the primary care physician by providing a treatment recommendation as part of the PSG interpretation, by providing informal consultation, and by the ready accessibility of the weekly case management conferences to primary physicians. This degree of informal involvement by sleep specialists may not be achievable in other settings, and may limit the generalization of our results. Certainly, physicians without adequate training should not be encouraged to manage CPAP patients without consultative support. On the other hand, primary care physicians may be ideally suited to promote CPAP compliance, because they have more follow-up opportunities and can reinforce CPAP compliance more regularly than consultants.

For primary care physicians, the learning curve for treating sleep disorders may be relatively short. By analogy, when survival rates of AIDS patients cared for by primary care physicians are compared, experience with just six cases improved survival significantly, to a level comparable with other major centers [20].

We determined CPAP user or returned status based on the patient's subjective report, rather than an hour meter. Many other investigators have used a similar compliance definition [17,21–28] and studies which compare subjective reports of CPAP use with an hour meter rating find a consistent 1 h overestimation by the patient [10], suggesting that when averaged, subjective reports accurately reflect relative CPAP use. In addition, return of a CPAP machine does represent an unambiguous, clinically and financially relevant endpoint.

The number of questionnaire non-responders is small (24%), and seems unlikely to significantly bias our results as there were no significant differences in the PSG results, co-morbid conditions, or sleep diagnoses between the responders and non-responders, except for age and diagnosis of PLMS. In addition, the home medical company which serviced the majority of our CPAP patients rated the suspected CPAP compliance of patients on a 0–10 scale (10 being excellent). For the 99 home medical-rated CPAP users, the average score was 7.28; for the 24 CPAP returns, the average score was 0.33. The average rating for their patients ($n = 37$) not responding to our questionnaire was 3.41, further supporting the conclusion that questionnaire non-responders are not a skewed population.

During this study, 33 patients (31 users, two returns) received CPAP after a split-night study, usually by meeting the then-current laboratory thresholds of an RDI of $\geq$40 and nadir SaO_2 of $\leq$80%. Thus, sleep apnea severity and split-night status are co-variates. Since disease severity and CPAP compliance are weakly correlated, the laboratory cut points for instituting CPAP therapy under a split-night protocol may influence eventual CPAP compliance, although only a randomized, controlled trial can settle this issue definitively.

Sleep apnea syndrome is a disease affecting millions of Americans. Faced with limited health care resources and the need to diagnose and treat a staggering number of patients, new strategies for health care delivery are urgently needed. This paper highlights two areas for further study and development: better selection of patients for CPAP treatment, and increased involvement of primary care physicians in the management of sleep apnea patients.

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Appendix A (see next page)

Pt _____ Study Date: _____

CPAP/BiPAP® QUESTIONAIRE

Please fill out as completely as possible, and return at your earlierst convenience. Your comments are welcome as we try to improve our program. For simplicity, CPAP will be used to signify both CPAP and BiPAP for this questionaire. When answering questions with a bar labelled at both extremes, make a hash mark perpendicular to the bar, indicating your response. Please be as honest as possible.

A. YOUR EQUIPMENT USAGE

1. Are you currently using CPAP? (Check only one) ☐Yes ☐No ☐Returned machine
   (If you have returned your machine, please complete the rest of the questions, as they apply.)
   1 (a) Reason for return:

2. What is the approximate length of time you have been on CPAP? _____ months or years (cirlce one)

3. Your estimate of the average number of hours per night you wear CPAP: _____

4. Your estimate of the average number of nights per week you wear CPAP: _____

5. Your estimate of the average number of hours per night you sleep: _____

6. Overall, what percent of the time do you estimate you use your CPAP machine? (Make a hash mark to indicate your response on the scale below.)

   0% (Never) ——————————————— 100% (Always)

B. WHAT EQUIPMENT DO YOU USE ?

Please check all appropriate boxes .

7. Nose Mask ☐Yes ☐No
8. Nasal Pillows ☐Yes ☐No
9. Chin Strap (to keep mouth closed): ☐Yes ☐No
10. Humidifier ☐Yes ☐No
11. Heated Humidifier ☐Yes ☐No
12. CPAP ☐Yes ☐No
13. BiPAP® ☐Yes ☐No
14. If known, please write your pressure setting: _____
15. Please note the brand of your CPAP machine: _____

C. DO YOU HAVE PROBLEMS WITH THE EQUIPMENT?

Please rate your satisfaction with the following pieces of equipment by making a hash mark on the scales.

16. Nasal mask of nasal pillows:

Terrible — Terrific

A. Describe any problems you are having and any solutions you have found:

17. Headgear (to secure mask):

Terrible — Terrific

A. Describe any problmes you are having and any solutions your have found:

18. Chin Strap (If worn; to keep mouth from opening):

Terrible — Terrific

A. Describe any problems you are having, and any solutions you have found:

19. Humdifier of heated humidifier (if used):

Terrible — Terrific

A. Describe any problems you are having, and any solutions you have found:

20. Tubing:

Terrible — Terrific

A. Describe any problems you are having, and any solutions you have found:

21. CPAP machine:

Terrible ——————————————— Terrific

21 (a). Is the pressure setting causing you difficulty?

Intolerable ——————————————— No problem

A. Describe any probems you are having, and any solutions you have found:

22. Effects of the apparatus on a bed partner (if present): ☐No bed partner

Intolerable ——————————————— No problem

A. Describe any problems you are having, and any solutions you have found:

23. Any other problems? ☐Yes ☐No Describe below:

D. SATISFACTION:

Mark the scale with an appropriate hash mark to indicate your response.

24. Overall, how would you rate your satisfaction with CPAP treatment, if using:
☐ Not using

Terrible ——————————————— Terrific

25. How would you rate your satisfaction with the testing and CPAP titration process?

Terrible ——————————————— Terrific

26. How would you rate your satisfaction with your physician's handling of your sleep disorder?

Terrible ——————————————— Terrific

27. Did you get a sleep consult from Dr. Ball or Dr. Simon? ☐Yes ☐No

27 (a). Was this helpful to you?

Not at all — Very Much

28. Were you adequately informed about the testing process by your physician?

Not at all — Completely

29. Were you adequately informed about the testing process by the technician(s)?

Not at all — Completely

30. How would you rate your satisfaction with Home Medical?
☐ Not serviced by Walla Walla Home Medical

Terrible — Terrific

31. How much did your sleep disorder interfere with your daily life before treatment?

Not at all — Tremendously

32. How much has CPAP treatment improved the way you feel?

Not at all — Tremendously

33. Do you feel you need more information about your sleep disorder, or its treatment?

Yes, a lot — I'm informed enough

34. Did you have difficulty with insurance coverage for your sleep disorder?

Yes, a lot — None at all

35. Please write any specific suggestions for how we might improve our program:

36. Are you interested in being part of a patient support or advocacy group?
☐ Yes ☐ No

Thank you very much for your help with this survey!
The Walla Walla Clinic Sleep Disorders Center
(The Kathryn Severyns Dement Sleep Disorders Center)