Increased Adherence to CPAP With a Group Cognitive Behavioral Treatment Intervention: A Randomized Trial

Dianne Richards, BSocSci (Hons)[1,2,4]; Delwyn J Bartlett, PhD[2,3]; Keith Wong, MBBS[1-3]; John Malouff, PhD[4]; Ronald R Grunstein, MD[2,3]

[1]Royal North Shore Hospital, St Leonards, Sydney, Australia; [2]Sleep and Circadian Research Group Woolcock Institute of Medical Research, University of Sydney, Sydney, Australia; [3]Royal Prince Alfred Hospital, Camperdown, Sydney, Australia; [4]University of New England, Armidale, NSW, Australia

Study Objective: To improve adherence to continuous positive airway pressure (CPAP) treatment in participants with obstructive sleep apnea (OSA) using a cognitive behavioral therapy (CBT) intervention.
Design: A randomized controlled trial.
Setting: A major teaching hospital in Sydney (2005).
Participants: One hundred individuals (96 men), ranging in age from 32 to 81 years, diagnosed with OSA.
Intervention: Two 1-hour CBT interventions (including a video of real CPAP users) plus treatment as usual (mask fitting and information) or treatment as usual only.
Measurements and Results: Hours of CPAP usage was assessed at 7 nights and 28 nights. Adherence was defined as usage at least 4 hours per night. Questionnaires measuring self-efficacy, social support, and expectancy (mediators of adherence) were given after intervention or after usual treatment. A higher adherence to CPAP therapy was found in the CBT group (2.9 hours difference) relative to treatment as usual ($P < 0.001$) at 28 days. Only 4 participants in the CBT group did not initiate treatments after their titration study, compared with 15 in the treatment as usual group ($P < 0.02$) The CBT group had significantly higher scores for self-efficacy ($P < 0.001$) and social support $P < 0.008$) but not for expectancy.
Conclusions: The CBT intervention resulted in both increased adherence and "uptake" of CPAP and therefore would be expected to reduce the social, economic, and health-related consequences of untreated OSA.
Keywords: Obstructive sleep apnea, continuous positive airway pressure, cognitive behavioural therapy, adherence.
Citation: Richards D; Bartlett DJ; Wong K et al. Increased adherence to cpap with a group cognitive behavioral treatment intervention: a randomized trial. *SLEEP* 2007;30(5):635-640

OBSTRUCTIVE SLEEP APNEA (OSA) IS A COMMON SLEEP DISORDER ASSOCIATED WITH EXCESSIVE DAYTIME SLEEPINESS AND CARDIOVASCULAR DISEASE.[1,2] Continuous positive airway pressure (CPAP) is an accepted treatment that improves neurocognitive performance and survival rates.[3-6] However, the treatment has high efficacy but low effectiveness, with refusal rates for adherence ranging from 5% to 50% in the first week to 6 months.[7] Continued CPAP usage is best predicted by reduced daytime somnolence.[7-9] Adherence has been arbitrarily defined as using the device for greater than 4 hours, 5 nights per week, while many individuals start and remain only intermittent users.[10-13] However, there is emerging evidence that longer periods of nightly use may improve outcomes, including neurocognitive function,[14] sleepiness,[15] diabetic control,[16] and excess sympathetic activity.[17]

Most CPAP-usage studies investigate individuals who commence treatment, with little data available on those individuals who refuse treatment before titration studies. In 1 study of 149 participants, initial refusal accounted for 27 dropouts (18%) with another 24 (16%) after 2 weeks use. By 30 months, only 50% of the participants were still using CPAP, with a mean usage of 3.6 hours per night.[13]

Only a few studies have evaluated behavioral interventions designed to improve CPAP use, with the findings somewhat equivocal.[18] One randomized, controlled, parallel-group study compared intensive support (including hospital CPAP supervision) to standard CPAP support, which increased CPAP usage by almost 2 hours per night.[19]

In another similar study providing positive reinforcement (regular telephone contact with a CPAP nurse), CPAP usage was not increased.[20] However, employing a CPAP education video using actors discussing CPAP in lay terms did increase attendance at a CPAP care follow-up appointment, compared with a non-video education group.[21]

Behavioral approaches based on social cognitive therapy have recently been studied to improve adherence to CPAP.[22-27] Social cognitive theory relates to how humans make choices. Perceptions and expectations derived from past experiences influence how the person acts whereas the provision of accurate information enhances new learning experiences and can correct faulty or irrational beliefs through exposure to positive stimuli.[28] Self-efficacy is a key component and relates to a belief in one's ability to accomplish some future behavior but within guidelines of setting realistic goals and the sharing of positive experiences by realistic models most like ourselves (real CPAP users).[27] Previous research with a small randomized intervention study (n = 12) based on self-efficacy and decisional balance found improved adherence to CPAP.[22] Social cognitive theory has also been shown to be effective in increasing medication adherence in asthma treatment.[29]

The purpose of this study was to examine whether an education intervention based on components of social cognitive theory and executed using CBT improved acceptance and adherence to CPAP in participants with OSA in a randomized trial.

Disclosure Statement
This is not an industry supported study. Mayo Health Care (Australia) provided all study participants use of Respironics CPAP machines. Dr. Grunstein has received research support from GlaxoSmithKline, Sanofi-Aventis, Cypress Bioscience, Neurocrine, and Abbott and has received travel sponsorship from Respironics. Dr. Richards, Bartlett, Wong, and Malouff have indicated no financial conflicts of interest.

Submitted for publication July, 2006
Accepted for publication January, 2007
Address correspondence to: Dr Delwyn Bartlett, Sleep & Circadian Research Group, Woolcock Institute of Medical Research, PO Box M77, Camperdown, NSW 2050 Australia; Tel: +61 2 9515 8530; Email: delwynb@med.usyd.edu.au

METHODS

Participants

Participants were recruited following diagnosis with OSA and referral for a CPAP-titration study. Recruitment took place between March and July, with follow-up completed in October of 2005. Individuals were asked to participate in an intervention that could improve their ability to use CPAP but were not informed that this was an adherence study, nor which group they had been assigned. Exclusion criteria included an inability to understand fluent English and previous use of CPAP. All participants gave informed consent.

Randomization

An investigator not involved with recruitment or provision of treatment independently randomized participants using a sequence generated with a blocking factor of 4. Allocation concealment was achieved with sequentially numbered, opaque, sealed envelopes. Of the 109 individuals approached, 9 refused to participate. Consenting participants were randomly assigned to either a treatment as usual group (TAU) (n = 50) or to the CBT group (n = 50).

Procedure

Intervention

Using some components of social cognitive theory (increased perceived self-efficacy, outcome expectations, and social support), we developed a CBT intervention designed to correct distorted beliefs, promoting a positive outlook to treatment with such catchphrases as "sleep safely using CPAP." We also aimed to increase sleep and CPAP knowledge but did not assess this component. Participants attended 2 one-hour sessions spaced 1 week apart with approximately 10 participants and their partners in each session, which was based on a CBT community model for insomnia treatment.[30] A standardized slide presentation gave information about normal sleep, daytime and nighttime health consequences of OSA (cardiovascular and driving/occupational accident risks), and the effectiveness of CPAP treatment (more energy for family/relationships, participation in sport, possible weight loss). A CPAP machine was displayed, and participants were encouraged to handle a mask but not wear it. A demonstration of simple relaxation strategies was also given to reduce any possible anxiety with using the CPAP mask.

A 15-minute video (made especially for the study) was presented of age-appropriate real-life male and female CPAP users ("role models") who described their personal experiences of learning to manage CPAP. The key message from the video was the need to persevere with the treatment and to ask for help from the sleep unit staff because there were long-term health benefits with CPAP usage. The role models also stated that daytime energy levels, cognitive abilities, mood, and general health had all improved with nightly usage of CPAP.

An additional booklet, containing information about sleep, OSA/CPAP, and general health (exercise, diet, effects of alcohol) was provided. Images of the 2 successful role models were used as symbols of success, along with a list of unhelpful thoughts associated with treatment and being able to reframe them into more helpful and realistic thoughts and goals in relation to CPAP usage.

Treatment as Usual

All participants attended treatment as usual, which consisted of 1 standardized group education session (usually with 3 participants). The CPAP-titration process was explained, and participants were familiarized with both the equipment used and the procedure to be followed on the titration night. Possible side-effects encountered when using CPAP were highlighted, and all participants were strongly encouraged to contact staff to obtain relevant help and support. Participants were assessed and fitted with a comfortable well-sealed mask to be worn during the titration study.

Blinding

Staff members were blinded to which group participants had been allocated and the 3 usual CPAP therapists strictly adhered to a script. After participants had used their CPAP for 7 nights and 28 nights, a sleep-unit staff member telephoned participants to request that the data card from the device be returned to the distributor by mail.

CPAP Titration

Subjects underwent an in-laboratory manual titration of their CPAP under polysomnography. CPAP-therapy pressure was titrated to treat apnea, hypopnea, and flow limitation, with a therapy target of less than 5 events per hour of sleep. A prescription for an appropriate CPAP pressure and a suitable fitting mask were given to all participants. Information was also given to participants on how to obtain their CPAP device from 1 specific CPAP distributor (no costs to be incurred during the study), but they were aware that the mask and tubing was their financial responsibility. Subjects were asked to start using CPAP. Participants had a routine half-hour appointment at the Sleep Investigation Unit (SIU) during the fourth week, unless earlier difficulties with therapy were encountered.

Apparatus

All participants were provided with a REMstar Pro CPAP (Respironics Inc., Murrysville PA) device with a data-storage SmartCard at no cost. The data card recorded time while the mask was on the face.[31] The returned data cards were downloaded by staff at the CPAP distributor and automatically analyzed using the Encore Pro software (Respironics Inc., Murrysville PA). The mask-on time for the period was calculated and divided by the number of nights (7 nights or 28 nights) to obtain a mean daily usage.

Outcome Measurements

Mean hours of CPAP usage (measured by mask-on time) at 28 days was the primary outcome, with secondary outcomes being the mean usage at 7 days and the proportion of adherers at 7 and 28 days.

Only 3 of the Social Cognitive Theory subscales (self-efficacy social support and outcome expectancy) used by Stepnowski and colleagues were given after CBT and after treatment as usual but before participants commenced CPAP.[32] Self-efficacy measures participants' beliefs in their ability to use CPAP. Outcome expectations measure the belief that, by using CPAP, sleep apnea will

be managed and improvements in daytime sleepiness and concentration will result. Social support measures access and input of key support people in participants' lives (family, friends, medical staff) and their influence on treatment and nightly use of CPAP. Participants selected from a 5-point scale, ranging from disagree completely to agree completely, for all the measures of self-efficacy, outcome expectations, and social support. The questionnaire format used is available by request.

The Depression Anxiety Stress Scale consists of a 21-item scale relating to depression, anxiety, and stress symptoms and was administered at baseline for both CBT and treatment as usual groups.[33]

The Epworth Sleepiness Scale is an eight-statement 4-point scale that measures situational daytime sleepiness experienced prior to commencement of CBT and treatment as usual. Any score higher than 10 is considered to be a marker of excessive daytime sleepiness. [34]

Statistical Analysis

Analysis was by intention to treat, and we measured hours of usage of CPAP at 28 days. Outcomes between groups were compared with independent samples t-tests and the χ^2 test for the difference in proportions. Logistic regression analysis explored predictors of use at 28 days, as defined by average use of at least 4 hours per night, which was selected a priori and is based on previous research adherence parameters of hours and percentage of nightly usage.[10,12] Variables considered included treatment group, sex, body mass index, respiratory disturbance index, Epworth Sleepiness Scale and Depression Anxiety Stress Scaale scores. Variables with P values of < 0.1 at univariate analysis were included in the multivariate model. Based on the primary analysis, it was estimated that 90 participants would be required to complete the study to detect a difference in mean usage of moderate effect size (0.6 standard deviations), with a 2-tailed significance level of 0.05, and power 0.80. The recruitment target was 100, to account for loss to follow-up. SPSS (version 13, SPSS Inc, Chicago, IL) was used for this analysis.

All participants gave informed consent, and the study was approved by the Northern Sydney Health Human Research and Ethics Committee, Sydney, and by the Human Ethics Committee University of New England, Armidale, New South Wales, Australia.

Table 1—Characteristics of Participants

Characteristic	Group	
	CBT	Treatment as usual
Men/women, no.	46/4	40/10[a]
Age, y	56.1 ± 11.8	56.2 ± 12.5
BMI, kg/m^2	30.4 ± 5.1	30.1 ± 4.9
RDI, events/h	27.6 ± 21.2	25.3 ± 23.1
Arousal Index, events/h	43.0 ± 23.6	42.4 ± 21.6
Minimum saturation, %	77.5 ± 12.6	80.4 ± 10.8
ESS, score	10.3 ± 5.0	10.6 ± 5.4
DASS		
Depression	8.1 ± 9.6	7.8 ± 8.0
Anxiety	8.4 ± 10.4	8.5 ± 7.6
Stress	13.2 ± 12.1	12.6 ± 9.5

Data are presented as mean ± SD. CBT refers to cognitive behavior therapy; BMI, body mass index; RDI, Respiratory Disturbance Index; ESS, Epworth Sleepiness Scale; DASS, Depression Anxiety Stress Scale

[a]P = 0.15. All other comparisons were P > 0.2

RESULTS

All participants had mild to severe OSA, as measured by a respiratory disturbance index of more than 5 events per hour. The sample contained moderately obese individuals with a body mass index ranging from 19 to 41 and an age range of 32 to 81 years. Table 1 shows the baseline characteristics of the participants. No differences were found between the groups at baseline in sex, age, body mass index, respiratory disturbance index, Epworth Sleepiness Scale scores, and Depression Anxiety and Stress Scale scores. Figure 1 describes the flow of participants through the study. After attending the CPAP-pressure determination study, 2 participants were withdrawn from the study. One participant allocated to CBT was found to require bilevel noninvasive ventilation, and a participant allocated to treatment as usual went overseas for an indefinite period of time. The data from these participants were excluded from the outcome analysis at 7 and 28 days. The SmartCard data from 2 participants at 28 days was lost in the mail, and these data were also excluded from this part of the analysis.

Table 2 shows the number of participants from each group who either refused the initial overnight CPAP-titration sleep study or did not take a CPAP machine home.

Table 2—Stages in the refusal of CPAP and hours of CPAP use

	CBT	TAU	P
Rejected CPAP prior to titration study	0	3	=0.25
Did not take CPAP machine home after titration	4	17	=0.002
Mean nightly CPAP usage (mask-on time) over 7 days (hours)	5.90 (2.31)	2.97 (2.88)	< 0.0001
Mean nightly CPAP usage (mask-on time) over 28 days	5.38 (2.55)	2.51 (2.70)	< 0.0001
Proportion using CPAP >= 4 hours/night at 7 days	43/49	19/49	<0.0001
Proportion using CPAP >= 4 hours/night at 28 days	37/48	15/48	<0.0001
Proportion using CPAP >= 6 hours/night at 28 days	24/48	7/48	= 0.0005
Self efficacy	4.20 (0.72)	3.6 (0.9)	<0.0001
Social support	4.43 (0.81)	3.97 (0.88)	<0.008
Outcome expectations	7.02 (0.75)	6.94 (1.03)	= 0.6

P values are for independent samples t-tests between treatment groups for continuous variables, and chi square test for proportions.

Table 3—Logistic Regression Model Predicting Adherence to CPAP

Variable	Univariate OR	Univariate P	Multivariate OR	P Value
Age, y	0.98 (0.95-1.02)	0.4		
Sex, female	0.18 (0.04-0.64)	= 0.007	0.22 (0.04-0.88)a	= 0.03
BMI, kg/m^2	1.06 (0.97-1.15)	0.22		
RDI, events/h	1.01 (0.99-1.03)	0.32		
Group, CBT	7.40 (3.07-19.6)	< 0.0001	6.89 (2.79-18.2)a	< 0.0001
ESS, units	1.03 (0.96-1.12)	0.4		
DASS				
Depression	0.99 (0.95-1.04)	0.7		
Anxiety	1.00 (0.95-1.04)	0.9		
Stress	1.01 (0.97-1.05)	0.7		

[a]Confidence intervals (CI) are generated from the Wald approximation to the log-likelihood; P values are calculated from likelihood ratio χ^2 tests. CPAP refers to continuous positive airway pressure; OR, odds ratio; BMI, body mass index; RDI, respiratory disturbance index; CBT, cognitive behavior therapy; ESS, Epworth Sleepiness Scale; DASS, Depression Anxiety and Stress Scale.

Core Outcome Measure

Mean nightly usage (mask-on time) at 28 days was 2.9 hours per night longer in the CBT group, compared with the treatment as usual group (t = 5.4, P < 0.0001, 95% confidence interval [CI] of difference 1.8-3.9 hours, effect size 1.1). At 1 month, 37 participants (77%) were using CPAP for at least 4 hours a night in the CBT group, compared with 15 participants (31%) in the treatment as usual group. The difference in usage between the groups remained significant (absolute difference in proportions 45.8% (CI 31%-77%), χ^2 = 18.5, P = 0.002). Mean nightly usage at 7 days was 5.9 and 3.0 hours per night in the CBT group and the treatment as usual group, respectively with a large difference in usage between groups of 2.9 hours (t = 5.5, P < 0.0001, 95% CI 1.9-4.0, effect size 1.1). At 7 days, 43 of 49 (88%) of participants in the CBT group were using their CPAP for at least 4 hours a night, as compared with 19 of 49 (39%) in the treatment as usual group. The absolute difference in proportions of 49% (CI 30%-67%) is significant (χ^2 = 23.2, P < 0.001).

The number needed to treat is low at 2.2 (CI 1.3-3.2), indicating that only 2.2 participants would need to receive CBT in order to have 1 patient adherent to CPAP therapy at 28 days.

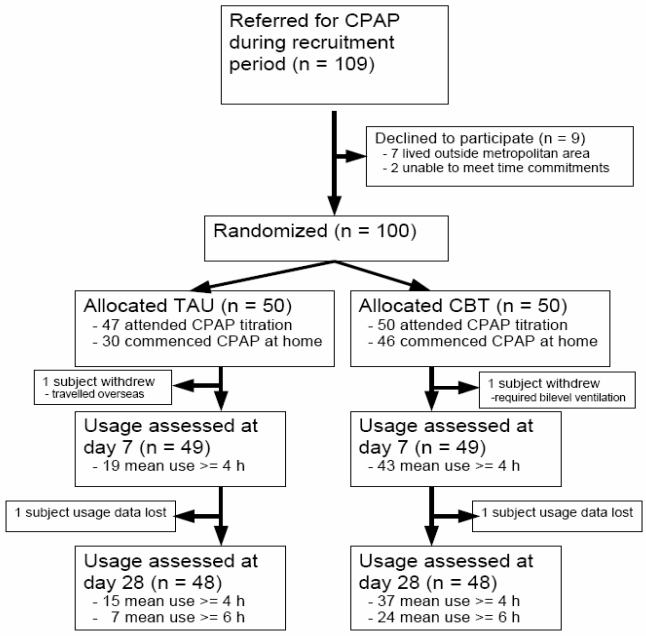

Figure 1—Continuous Positive Airway Pressure (CPAP) Trial Flow Diagram. TAU refers to treatment as usual; CBT, cognitive behavior therapy.

Secondary Analyses

We used logistic regression modeling to explore predictors for CPAP adherence at 28 days (Table 3). Psychological factors did not contribute to the model. Treatment group and sex were included in the final model. Adjusted for the effect of sex, participants in the CBT group were 6.9 times more likely to adhere to CPAP than the treatment as usual group (adjusted odds ratio 6.9, CI 2.8-18.2). There was no significant group-by-sex interaction (P = 0.8), indicating no significant difference in treatment response between men and women.

The Self-Efficacy, Social Support, and Expectancy Scales

Those taking part in the CBT group had significantly higher scores for self-efficacy (4.20 ± 0.72 vs 3.6 ± 0.9; P < 0.001) and social support (4.43 ± 0.81 vs 3.97 ± 0.88; P < 0.008), compared with the treatment as usual group. However, there was no difference in the level of treatment outcome expectations between the CBT and treatment as usual groups (7.02 ± 0.75 vs 6.94 ± 1.03; P = 0.64).

Did Having a Bed Partner Attend the Session Influence Adherence to CPAP?

Attendance of the bedpartner was only recorded for the CBT group. There was no difference in adherence rates (≥ 4 hours per nightly usage at 28 days between those participants without a partner attending [n = 9; 90%] and those with a partner present [n = 28; 74%] [P = 0.4 by Fisher Exact Test]).

DISCUSSION

This is the first randomized trial demonstrating how a CBT

intervention in addition to treatment as usual increased participant acceptance and adherence of CPAP. In this study, 30% of the treatment as usual group refused CPAP either before or after the titration study, compared with 8% of the CBT group. At 28 days, only 31% of the treatment as usual group was using CPAP for 4 hours or more per night, and approximately 15% for more than 6 hours. In contrast, 77% were using CPAP for at least 4 hours in the CBT group, with 50% using CPAP for at least 6 hours (Figure 1). The two 1-hour sessions in addition to standard treatment suggests a high economic return; given the low number needed to treat, the reduced drop out, and the fact that this treatment intervention can be administered in a group setting has major positive health implications.

Although resolving negative side effects that inhibit treatment tolerance is important, this study emphasizes the effectiveness of CBT by increasing both self-efficacy and CPAP adherence. Self-efficacy was significantly increased in the CBT group but not the treatment as usual group, but no differences were found with outcome expectations. This was somewhat surprising given our expectation that the video presentation would encourage the CBT group to not only persevere with any initial treatment difficulties, but also be influenced by the positive outcomes (safer driving and reduced daytime sleepiness) from regular CPAP usage. However, self-efficacy significantly impacted on the CBT group, possibly by raising confidence levels with increased knowledge and familiarity about CPAP. The CBT group also felt more socially supported, which is likely to be a combination of family, medical, and the research involvement. Of key importance is that some part or most of this intervention enabled individuals to use CPAP on a nightly basis, which is a primary goal of treatment.[7] The group CBT intervention was both simple and relatively inexpensive, in contrast to previous labor-intensive support interventions.[19,20,35]

Previous research has indicated that symptoms of excessive daytime sleepiness best predict CPAP treatment and adherence, whereas CPAP is ineffective in the absence of daytime sleepiness.[7,8,36,37] In this study, participants in both groups were equally sleepy, and Epworth Sleepiness Scale scores did not account for any of the variance in mean CPAP usage. We also found that CPAP use was lower in women compared with men, although there was no difference in treatment response. Previous research found that male partners are less tolerant of snoring in their female partners.[38] Subsequently, women may perceive wearing a mask as being less feminine and is possibly a salient factor in treatment acceptance and adherence in a shared bed. Future investigation of the impact of female sex on CPAP use is warranted.

Bedpartners were invited to the CBT sessions on the basis of previous research recommendations.[21, 26] In the treatment as usual group, partners attended the session only if specifically requested. The presence of bedpartners did not predict CPAP adherence within the CBT group. Previous research found that treatment instigated by the bedpartner is associated with reduced CPAP usage, compared with a patient-initiated treatment process.[19] Although we originally believed that the presence of a bedpartner would be a significant factor in giving participants social support in the CBT group, partner presence did not predict adherence within that group. Future research is necessary to explore the role of partner presence in such an intervention in which participants are randomized to an arm of partner presence or no-partner presence. Similarly, randomizing patients to CBT including and excluding certain other factors of the program or varying time spent with the patients would help to determine which components of the CBT led to such a marked improvement in adherence.

Although the results of this study are encouraging, the 1-month follow-up may require caution when generalizing these results to long-term adherence. Previous research has found significant differences in CPAP adherence beyond 1month of a CPAP trial.[39] Future longitudinal research is needed to clarify whether a CBT intervention provides a durable positive effect.

We did not provide a true "placebo" in this CBT intervention but, instead, tested whether CBT *in addition* to standard care at our center would enhance CPAP acceptance and adherence. Our treatment effect size of the treatment effect is large, but this study cannot confirm that the increased adherence and usage is totally due to the CBT intervention alone. The active-intervention group did differ from the treatment as usual group with respect to time involved with participants (2 extra hours), number of visits (3 visits compared with 1 visit), and the effect of the content of the CBT program itself. However, before we could control for the various components of the above-listed factors of our intervention, we felt it was important to test whether there was any effect of CBT intervention at all.

Although no specific information on socioeconomic status of the study population was collected, the hospital is located in an area of higher education and income levels than are other regions of Sydney, and results may not generalize to a different community. However, it seems that Social Cognitive Theory takes into account social milieu, and comparable results may be predicted with appropriate modifications to the CBT program. An economic analysis of the cost of the CBT intervention was not included, but, given the low number needed to treat, the reduced dropout rate, and the fact that this treatment intervention can be administered in a group setting, suggests a high economic return. A previous CBT intervention, although effective at 12 weeks, was also labor intensive (one to one with psychologist),[22] whereas our program could potentially be performed by individuals without specific psychologic training because it was based on a community-education insomnia format.[30]

The reduction in the attrition rate from diagnosis of OSA to CPAP treatment found in this study is important. We believe that the instigation of a CBT program immediately following referral for CPAP kept participants engaged in the treatment process and reduced psychiatric comorbidity.[40] Previous research has also found that early-intervention strategies encouraging the use of CPAP are more likely to target those individuals who are less likely to proceed with treatment.[7] In contrast, if such support is withheld (as in the treatment as usual arm) or as in previous research of a second-arm cross-over study using verbal reinforcement to increase adherence,[20] no improvement in hours of usage was found, and, for us, there was a drop in posttitration acceptance of CPAP.

In conclusion, a brief CBT intervention produced marked improvement in initializing CPAP prescription acceptance, adherence, and usage, compared with standard care. These data will need to be confirmed in other populations and clinical settings but provide encouragement for the development of CBT-related therapies in improving acceptance and adherence to CPAP.

ACKNOWLEDGMENTS

We acknowledge the contribution of the following individuals:

Alison and Lucinda Badger (technical assistance and video); Drs. David Joffe and Michael Hibbert (patient recruitment); Debra Hackett, David Bolton, and Maria Baric (assisted with the treatment as usual and cognitive behavior therapy intervention); Laurie Cree and Beverley Old (continuous positive airway pressure users on the video); Judith Wells (continuous positive airway pressure bookings), and Mayo Healthcare and Respironics for providing CPAP equipment and downloading data. The study was supported by an NHMRC postgraduate scholarship to KW, an NHMRC Practitioner fellowship to RRG, NHMRC Grant #253792, and the NHMRC Centre for Clinical Research Excellence in Respiratory and Sleep Medicine.

As corresponding author (DJB): I had full access to all of the data in the study, and I take responsibility for the integrity of the data and the accuracy of the data analysis.

REFERENCES

1. Bearpark H, Elliott L, Grunstein R, et al. Snoring and sleep apnea. A population study in Australian men. Am J Respir Crit Care Med 1995;151:1459-65.
2. Flemons W. Obstructive sleep apnea. N Engl J Med 2002;347:498-504.
3. McFaydon T, Espie C, McArdle N, Douglas N, Engleman H. Controlled prospective trial of psychosocial function before and after continuous positive airway pressure therapy. Euro Respir J 2001;18:996-1002.
4. Orth M, Duchna H, Leidag M, et al. Driving simulator and neuropsychological testing OSAS before and after CPAP therapy. Euro Respir J 2005;26:898-903.
5. Campos-Rodriguez F, Pena-Grinan N, Reyes-Nunez N, et al. Mortality in obstructive sleep apnea-hypopnea treated with positive airway pressure. Chest 2005;128:624-33.
6. Marin JM, Carrizo SJ, Vicente E, Agusti AG. Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study. Lancet 2005;365:1046-53.
7. Engleman H, Wild M. Improving CPAP use by patients with the sleep apnea/hypopnea syndrome (SAHS). Sleep Med Rev 2003;7:81-99.
8. Meurice J, Dore P, Paquereau J, et al. Predicitve factors of long-term compliance with nasal continuous positive airway pressure treatment in sleep apnea syndrome. Chest 1994;105:429-33.
9. Engleman H, Asgari-Jirhandeh N, McLeod A. Self-reported use of CPAP and benefits of CPAP therapy. Chest 1996;109:1470-6.
10. Barone-Kribbs N, Pack A, Kline L, et al. Effects of one night without CPAP treatment on sleep and sleepiness in patients with obstructive sleep apnea. Am Rev Respir Dis 1993;47:1162-8.
11. Weaver T, Kribbs N, Pack A, et al. Night-to-night variability in CPAP use over the first three months of treatment. Sleep 1997;20:278-83.
12. Fitzpatrick MF, Alloway CE, Wakeford TM, MacLean AW, Munt PW, Day AG. Can patients with obstructive sleep apnea titrate their own continuous positive airway pressure? Am J Respir Crit Care Med 2003;167:716-22.
13. Grote L, Hedner J, Grunstein R, Kraiczi H. Therapy with CPAP: incomplete elimination of sleep related breathing disorder. Eur Respir J 2000;16:921-7.
14. Weaver TE. How much is enough CPAP? Sleep Med 2003;4S1:S52.
15. Kingshott R, Vennelle M, Hoy C, Engleman H, Deary I, Douglas N. Predictors of improvements in daytime function outcomes with CPAP therapy. Am J Respir Crit Care Med 2000;161:866-71.
16. Babu A, Herdegen J, Fogelfeld L, Shott S, Mazzone T. Type 2 diabetes, glycemic control and continuous positive airway pressure in obstructive sleep apnea. Arch Intern Med 2005;165:447-52.
17. Waradekar N, Sinoway L, Zwillich C, Leuenberger U. Influence of treatment on muscle sympathetic nerve activity in sleep apnea. Am J Respir Crit Care Med 1996;153:1333-8.
18. Haniffa M, Lasserson TJ, Smith I. Interventions to improve compliance with continuous positive airway pressure for obstructive sleep apnoea. Cochrane Database Syst Rev 2004:CD003531.
19. Hoy C, Vennelle R, Kingshott R, Engleman H, Douglas N. Can intensive support improve continuous positive airway pressure use in patients with the sleep apnea/hypopnea syndrome? Am J Respir Crit Care Med 1999;159:1096-100.
20. Fletcher E, Luckett R. The effect of positive reinforcement on hourly compliance in nasal continuous positive airway pressure users with obstructive sleep apnea. Am Rev Respir Dis 1991;143:936-41.
21. Wiese H, Boethel C, Phillips B, Wilson J, Peters J, Viggiano T. CPAP compliance: video education may help! Sleep Med 2005;6:171-4.
22. Aloia M, Lina Di Dio M, Ilniczky M, Perlis M, Greenblatt M, Giles D. Improving compliance wiht nasal CPAP and vigilance in older aduts with OSAHS. Sleep Breath 2001;5:13-21.
23. Aloia M, Arnedt T, Riggs R, Hecht J, Borrelli B. Clinical management of poor adherence to CPAP: motivational enhancement. Behav Sleep Med 2004;2:205-22.
24. Aloia M, Arendt J, Stepnowski C. Predicting treatment adherence in obstructive sleep apnea using principles of behaviour change. J Clin Sleep Med 2005;1:346-53.
25. Weaver T. Predicting adherence to continuous positive airway pressure - the role of patient perception. J Clin Sleep Med 2005;1:354-6.
26. Weaver T, Maislin G, Dinges D, et al. Self efficacy in sleep apnea: Instrument development and patient perceptions of obstructive sleep apnea risk, treatment benefit and volition to use continuous positive airway pressure. Sleep 2003;26:727-32.
27. Bandura A. Human agency in social cognitive theory. Am Psychol 1989;44:1175-84.
28. Bandura A. Social Learning Theory. Englewood Cliffs, NJ: Prentice Hall; 1977.
29. Cochrane G, Horne R, Chanez P. Compliance in asthma. Respir Med 1999;93:763-9.
30. Espie C, Inglis S, Harvey L. Predicting clinically significant response to cognitive behavior therapy (CBT) for chronic insomnia in general practice: analyses of outcome data at 12 months post-treatment. J Consul Clin Psychol 2001;69:58-66.
31. Respironics. Encore sleep monitoring software. Murrysville, Penn: Respironics Corporation; 2001.
32. Stepnowsky C, Marler M, Ancoli-Israel S. Determinants of nasal CPAP compliance. Sleep Med 2002;3:239-47.
33. Lovibond S, Lovibond P. Manual for the Depression Anxiety Stress Scales, 2nd ed. Sydney: The Psychology Foundation of Australia Inc. University of New South Wales; 1995.
34. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep 1991;14:540-5.
35. Cross M, Vennelle M, Engleman H, et al. Comparison of CPAP titration at home or sleep laboratory in the sleep apnea/hypopnea syndrome. Sleep 2006; 29: 1451-1453.
36. Collard P, Pieters T, Aubert G, Delguste P, Rodenstein D. Compliance with nasal CPAP in obstructive sleep apnea patients. Sleep Med Rev 1997;1:33-44.
37. Barbe F, Mayoralas L, Duran J, et al. Treatment with continuous positive airway pressure is not effective in patients with sleep apnea and no daytime sleepiness. Ann Internl Med 2001;134:1015-23.
38. Grunstein R, Stenlof K, Hedner J. Impact of self-reported sleep-breathing disturbances on psychosocial performance in the Swedish Obese Subjects (SOS) study. Sleep 1995;18:635-43.
39. Aloia M, Stanchina M, Arnedt J, Malhotra A, Millman R. Treatment adherence and outcomes in flexible vs standard continuous positive airway pressure therapy. Chest 2005;127:2085-93.
40. Haynes P. The role of behavioral sleep medicine in the assessment and treatment of sleep disordered breathing. Clin Psychol Rev 2005;25:673-705.