

# Predictors of continuous positive airway pressure adherence

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## Abstract

Continuous positive airway pressure (CPAP) is the leading treatment for obstructive sleep apnoea (OSA), a prevalent disorder of breathing in sleep strongly associated with obesity. OSA has serious adverse health, social and community effects arising from disturbed breathing, loud snoring, poor quality sleep and cardiovascular sequelae. When used appropriately, CPAP treatment is highly effective in normalising breathing and sleep, improving symptoms and lowering adverse event risk. However, patients do not necessarily accept, tolerate or comply with treatment, with many factors influencing CPAP uptake and longer term use. Although knowledge to address challenges affecting CPAP adherence and CPAP mask and machine technologies continue to improve incrementally, optimising CPAP treatment adherence is an ongoing challenge in sleep medicine.

## Introduction and context

Continuous positive airway pressure (CPAP) is the first-line treatment for obstructive sleep apnoea (OSA), a prevalent breathing disorder characterised by frequent complete or partial airway collapse events that can severely disrupt normal breathing and sleep. OSA patients are usually overweight or obese and most frequently present with debilitating daytime sleepiness or problematic snoring affecting their bed partner. Left untreated, OSA is associated with impaired daytime performance, an increased risk of traffic and other accidents, hypertension, neuropsychological disturbances, and metabolic dysfunction independent of obesity [1-5]. Although definitive data are not yet available, cardiovascular and oxidative stress associated with OSA also appear likely to contribute to an increased risk of adverse cardiovascular events and sudden death [6,7].

CPAP treatment utilises a pressurised mask to pneumatically splint open and stabilise the upper airway during sleep. While somewhat cumbersome and not without side effects [8], CPAP is highly effective in normalising breathing in sleep and consequently improving sleep

quality and daytime symptoms [9,10]. However, CPAP only controls obstructed breathing events while an appropriately pressurised mask remains in place, with a single night of missed treatment sufficient for daytime deficits to return [11]. In addition, while symptom severity varies widely between patients, there are dose-response relationships between average hours of nightly use and the percentage of patients achieving normal values in measures of daytime sleepiness and function [12]. Studies showing improved survival in CPAP-adherent patients [13], increased mortality in severe untreated OSA irrespective of sleepiness [7], and reduced blood pressure in non-sleepy OSA patients using CPAP for most of every night [14] further support the need for good compliance with effective treatments.

Despite strong evidence supporting the benefits and effectiveness of CPAP, particularly in more severe cases, as well as improved access to treatment and major improvements in CPAP machine and mask technology over the past three decades, patient adherence to treatment frequently remains poor. Up to 50% of patients recommended CPAP may not have commenced

or be using treatment after 1-3 years [15,16]. In patients who commence CPAP, use may be intermittent and vary considerably between and within nights over time. A recent review suggests that 29-83% of patients average less than 4 hours of CPAP use per night [17], a somewhat arbitrary but the most frequent cut-off for defining non-adherence based on minimal criteria for adequate sleep [8,18]. Understanding the barriers to and predictors of CPAP treatment uptake and long-term adherence is therefore critical for successfully establishing and maintaining patients on effective CPAP treatment.

## Recent advances

### **Treatment compliance monitoring**

Modern CPAP machines provide objective measures of time spent at pressure. Consequently, unlike many treatments dependent on good patient co-operation, objective measures of treatment compliance are readily available. These are important for reliable monitoring given that poor treatment adherence is not uncommon in medicine and life-style interventions, that patients frequently over-report CPAP treatment adherence [18,19] and given the risks associated with untreated severe OSA.

### **Predictors of CPAP compliance**

Recent reviews examining predictors of CPAP adherence highlight that many factors contribute to treatment uptake and adherence over time [17,20,21]. Between 5 and 50% of patients recommended CPAP may simply reject treatment before even trying or soon after pressure titration and trial of CPAP, and a further 12-25% of patients commencing CPAP abandon treatment within 3 years [16]. Apportioning the relative contribution of factors contributing to adherence is difficult and statistical associations are often relatively weak. Nevertheless, the severity of OSA and symptoms, the early experience and effective trouble-shooting of treatment problems and side effects, appropriate and timely education and support, and behavioural and cost factors appear to be the main predictors of uptake and long-term compliance [16]. Differences in these factors between studies likely account for widely divergent CPAP rejection and adherence rates. Low initial rejection rates (~5%) are reported in a large series of patients with symptomatic OSA [22], compared to high rejection rates (~50%) in patients recommended CPAP on the basis of an apnoea-hypopnoea index of greater than 15 events per hour, regardless of symptoms [23]. This is consistent with symptom severity being a key determinant of initial CPAP uptake, although other factors, such as CPAP provision and follow-up practices, cannot be discounted.

### **Disease severity and symptom relief**

Symptom severity pre-treatment and symptom relief with CPAP treatment are consistently amongst the strongest predictors of CPAP compliance. Measures of OSA severity *per se* appear more weakly associated with CPAP adherence [16,17], although higher pressures are also associated with lower compliance, perhaps indicating confounding by side effects [24]. Severe but asymptomatic OSA patients show relatively low CPAP compliance and few signs of any treatment benefit [25], although increased mortality in untreated non-sleepy OSA patients suggests that treatment adherence may nevertheless confer benefit [7].

### **Side effects and complaints**

Side effects and complaints are common, perhaps affecting 30-70% of patients to varying degrees. In the main these include inconvenience, poor mask fit and discomfort, skin irritation, mask leaks and sore eyes, airway drying, nasal problems, complaints of noise and frequent awakening, claustrophobia, and dislike of CPAP treatment [8,16,26]. With appropriate management, side effects are unlikely to be a major impediment to adherence [10,16], with a recent study suggesting that health care personnel perceive side effects to be more of a problem for adherence than do patients [27]. Patient attitudes and behaviours may be a relatively more important significant challenge to CPAP treatment management.

### **Psychological factors**

Some of the key determinants of CPAP rejection and non-adherence may include apprehension regarding how CPAP will make patients look and feel, interference with normal life and sexual functioning, and other behavioural or psychological factors [28]. Models incorporating aspects of cognitive theory substantially account for variance in CPAP adherence [29-31], likely reflecting that behavioural and cognitive factors critically influence patient decisions to seek, accept, and adhere to treatment. The patient's and their partner's perceived benefit are predictors of improved CPAP adherence [16,32], while adherence is reduced if the patient's partner asked them to seek treatment (as opposed to the patient initiating their own referral) [33] and if patients sleep alone [34] or have a lower socioeconomic status [35], anxiety or depression [36]. A recent study showing higher lipid-lowering drug use in more CPAP compliant patients supports that medication and CPAP adherence behaviours are likely linked [37]. However, speculation that generalised non-adherent behaviours may account for poorer survival in CPAP non-adherent versus CPAP-adherent OSA patients with cardiovascular disease was challenged by a recent study showing no difference in

medication adherence between CPAP adherent versus non- or poorly adherent patients [38,39].

#### *Early experience, education and support*

Attitudes and beliefs as well as early problems and poor initial CPAP usage are strongly predictive of longer-term poor compliance [18,34,40-43]. Consequently, early interventions targeting issues surrounding CPAP knowledge, benefits and expectations, the initial novel experience, and common problems of trying to sleep with CPAP may be substantially alleviated via timely education and clinical management [16,27,28,31,33,44-47]. Adequate early education is clearly of major importance for addressing psychosocial and behavioural barriers to establishing effective CPAP treatment [31,44,48]. Proper mask fit and early management of technical problems such as nasal symptoms and air leak are clearly important [49,50]. Humidification to resolve airway drying may help improve compliance [51,52], although evidence to support long-term benefit is still lacking [20,21,53]. Data to compare patient compliance between mask types are also very limited [54], but appropriate mask choice and patient training are clearly needed to ensure comfort and good fit. Some group data support greater comfort and compliance with a nasal versus face mask despite more mouth leak related symptoms [55], although choice and fit tailored to individual patients likely facilitates improved adherence [54]. Some recent data suggest specific hypnotics used during initial CPAP titration [56,57] and early CPAP use [58] may help improve adherence in the short term by facilitating sleep during early acclimation to CPAP. However, hypnotics are already over-prescribed and have attendant risks, some hypnotics could influence OSA severity and CPAP titration, and there may be increased daytime risks if treatment and/or compliance remain suboptimal. Caution is therefore warranted with early hypnotic use, particularly in the absence of longer term outcome data.

#### *Improving technologies*

New masks and quiet, small and more sophisticated positive airway pressure machines continue to emerge in a competitive market. While the impact of new technologies on patient preference and treatment adherence remain largely to be established, there is some evidence that improved mask comfort and algorithms designed to modulate pressure to further improve patient comfort are useful in some patients [20,51,59,60]. However, the incremental benefits of auto-adjusting devices appear to be small [20,61] and treatment cost appears likely to be a significant barrier to uptake. While further trials are needed, new technologies allowing telemonitoring of CPAP compliance and

efficacy appear likely to be useful for simplifying early intervention to address treatment problems and adherence [45].

#### **Strategies to improve compliance**

Several recent studies show that CPAP adherence can be improved using strategies to address problems and barriers to patient acceptance and long-term treatment adherence [20,44,51,57,62]. For example, one study found 24% of 204 previously non-adherent patients became adherent following interventions to improve mask fit and comfort, nasal symptoms, and patient education, with a further 38% of persistently non-adherent patients continuing follow-up achieving adherence with secondary interventions [51]. Further systematic and longer-term data concerning CPAP implementation strategies are still needed to inform best practice for optimising long-term CPAP adherence [9,63]. Nevertheless, appropriate education and behavioural interventions are clearly important. Attitudes and beliefs are known to be key determinants of treatment adherence with other therapies [16], and available evidence indicates that the same is true for CPAP [28,29]. Consequently, early interventions to address knowledge gaps, set realistic treatment expectations, and modify behavioural barriers to establishing effective treatment may be critically important for maximising long-term CPAP acceptance and adherence.

#### **Rescue and alternative therapies**

Currently, CPAP clearly remains the first-line treatment for OSA with a strong evidence base to support its use. In patients who fail to accept or tolerate CPAP, the main alternative treatments include surgery, mandibular advancement splints, and weight loss. These may be more appealing to patients who are poorly compliant with CPAP, but effectiveness is more variable and some risks are not trivial (e.g., surgery). In addition, poor compliance may still be an issue and is more difficult to monitor with other non-surgical treatments. Other therapies, such as supine avoidance and interventions targeting more specific underlying abnormalities, may be suitable in carefully selected patients, but data to support their use are currently lacking.

#### **Implications for clinical practice**

Successfully establishing patients on CPAP therapy is challenging because of the variable nature of OSA, symptomatology, co-morbidities, psychosocial factors, and differing problems experienced by individual patients when commencing CPAP treatment. Appropriate education, mask and pressure selection, early interventions to address problems and side-effects, and follow-up support appear to be particularly important

for achieving good treatment outcomes. While evidence is still emerging, structured, multidisciplinary education and early management using cognitive behaviour and motivational approaches appear most likely to assist patients to initially accept and then adhere to CPAP treatment long-term [16,31,44]. Improved mask and CPAP machine technology may help improve treatment adherence in some patients, but non-technological factors appear to be more important determinants of longer-term CPAP adherence [16,62]. Evolving trends towards simplified and faster diagnostic and management strategies better equipped to deal with the large community burden of OSA [64] could positively and negatively impact adherence by addressing delays in establishing treatment while potentially undermining patient education and support [65]. Consequently, appropriate clinical management addressing the main barriers to treatment uptake and adherence is critically important for successfully establishing and maintaining patients on effective CPAP treatment long-term.

### Abbreviations

CPAP, continuous positive airway pressure; OSA, obstructive sleep apnoea.

### Competing interests

The author has received an equipment loan from Philips-Respironics and is an investigator on an industry-sponsored trial of a new implantable device treatment for obstructive sleep apnoea (Apnex Medical Inc.). The author's main research area is pathophysiological mechanisms in OSA, including new targeted treatment approaches.

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