Obstructive sleep apnea: impacting adherence, impacting prognosis

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Obstructive Sleep Apnea: Impacting Adherence, Impacting Prognosis

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2012
Dedication

This paper is dedicated to my parents, Al and Donna St. Pierre. It is because of their constant support and unwavering faith in me that I have been able to finish this stage of the journey.
Acknowledgments

I would like to thank April Gardner, PA-C, MSBS, for her encouragement and dedication to my success, not just in this current research project, but in my academic career.
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Background

Obstructive sleep apnea (OSA) is the term used to describe the chronic and cyclic respiratory obstruction during sleep associated with symptoms of disturbed sleep, most commonly excessive daytime sleepiness (Dempsey, Veasey, Morgan, & O'Donnell, 2010). Other common symptoms include snoring (Park, Ramar, & Olson, 2011) and frequent episodes of nocturia (Margel, Shochat, Getzler, Livne, & Pillar, 2006). Bed partners frequently report observed apneas. An apnea is defined as the stopping, or near stopping, of breathing. Airflow during apneic events is less than twenty percent of baseline for ten seconds or more for adults. Hypopneas refer to episodes of reduced, but not stopped, breathing. Both apneic and hypopneic events can result in arousal from sleep, increased arterial carbon dioxide (CO₂), and decreased oxygen (O₂) levels (Dempsey et al., 2010). Apneas can further be defined by occurring due to an obstructive source or central source. Central apneas, as the name implies, come from a source within the central nervous system with an absence of both airflow and respiratory effort. Obstructive apneas occur when airflow is absent, but respiratory effort persists. Typically the obstruction is the result of collapsed upper airway structures secondary to increased fat deposition in the area of the oropharynx and the natural skeletal muscle hypotonia that occurs during REM sleep. The work of breathing is increased against the obstruction (Lochan, 2011).

OSA is not a benign condition. Consequences of OSA related to the metabolic syndrome and cardiovascular disease contribute to the morbidity and mortality associated with OSA. On one end of the spectrum, excessive daytime sleepiness (EDS) associated with OSA can significantly impair activities of daily living. In fact, OSA is an independent risk factor for motor vehicle accidents. At the other end of the spectrum, sudden cardiac death can occur as the result of right heart failure.
The current gold-standard of treatment for OSA is continuous positive airway pressure (CPAP). CPAP provides a continuous column of air that acts as a physiologic splint to keep the upper airways patent during sleep. During times of wakefulness, the dilator muscles in the oropharynx exert tone on the airway compensating for the deposited adipose tissue and the negative intrathoracic pressure that is generated by the act of breathing. While asleep, however, the negative intrathoracic pressure is not compensated by the musculature of the throat. Physiologic skeletal muscle hypotonia while sleeping, combined with the increased adipose tissue in the oropharynx, and exacerbated by vibratory waves sent through the throat from snoring ultimately cause the airway to collapse leading to the obstructive event that is pathognomonic in OSA.

Adherence to CPAP therapy remains low, even as the consequences of OSA are illuminated. Many factors contribute to the low rate of compliance, however compliance, can be positively influenced. Motivational interviewing is one technique being investigated and adapted to impact compliance with CPAP therapy, ultimately impacting the prognosis of OSA with regards to morbidity and mortality. The purpose of the current literature review is to determine if psychological measures of adherence related to motivational interviewing techniques can positively impact compliance with CPAP therapy.
Introduction

Diagnostic Criteria

The gold standard for diagnosing OSA is by polysomnography, more commonly called a sleep study, when performed overnight in a sleep center with a qualified attendant. The data from the sleep study are used to create an apnea-hypopnea index (AHI). The AHI is determined by dividing the number of apneic or hypopneic events by the number of hours of sleep. A diagnosis of mild OSA is made when the patient has between five and fifteen events per hour and is relatively asymptomatic. Moderate OSA is defined as fifteen to thirty apneic or hypopneic events per hour of sleep. The patient is also aware of daytime sleepiness. A diagnosis of severe OSA is made when the patient has over thirty events per hour of sleep and/or an O₂ saturation of less than 90% for twenty percent or more of the total sleep time.

OSA is often underdiagnosed by clinicians and under-reported by patients (Yu & Berger, 2011). Up to 26% of adults in the United States are at high risk for OSA and an estimated 20% of the population has OSA (AHI > 5). Two to 9% percent of adults have OSA if it is defined as an AHI > 5 with symptoms that respond to treatment. This places OSA as second to asthma in the prevalence of chronic respiratory disorders (McNicholas, 2003). The prevalence of OSA increases with increasing age between 18 and 45 years of age and plateaus between 55 and 65 years. There is a two-to-three fold higher prevalence of OSA in those over 65 years of age when compared to those aged 30-64. When looked at in terms of race, younger and older African Americans appear to be at greater risk of developing OSA, independent of weight. Males develop OSA more than females until after menopause, when incidence becomes equal (Jennum & Riha, 2009). Among children, OSA affects between 2-5%, most commonly between the ages of 2 and 8 years (Bhattacharjee, Kim, Kheirandish-Gozal, & Gozal, 2011).
Pathophysiology and Consequences of Obstructive Sleep Apnea

The hallmark of OSA is the obstructive event during NREM sleep and the arousal from sleep required to restore breathing. The skeletal musculature of the upper airway that keeps the airway patent during wakefulness becomes atonic during sleep, like the other skeletal muscles of the body. The hyoid bone is a key anchoring site for pharyngeal dilator muscles. In humans, the hyoid bone is not attached to other structures. In other mammals, the hyoid is attached to the styloid processes of the skull. This lack of rigid attachment allows the lumen of the airway to vary with intrathoracic pressure.

Obesity is a major contributor to OSA. Fat deposition in the musculature contributes to the increased collapsibility of the oropharynx. Obesity also contributes to the relative hypotonia of the upper airway during sleep. Increased abdominal mass and recumbent posture contribute to decreased lung volumes. Decreased lung volumes then reduce the traction that is exerted on trachea by other structures in the mediastinum, making it more susceptible to collapse from negative intrathoracic pressures while breathing (Dempsey et al., 2010).

The OSA patient is at risk for several comorbidities, with the metabolic syndrome being one of the most common. Metabolic syndrome is a cluster of risk factors for cardiovascular disease and diabetes (Theorell-Haglow, Berne, Janson, & Lindberg, 2011). When three of the five criteria established by the National Cholesterol Education Program/Adult Test Panel III (NCEP/ATPIII) are met, a patient can be considered to have metabolic syndrome. These criteria are: abdominal (central) obesity (waist size > 40 inches in men and >35 inches in women); serum triglycerides $\geq$ 150 mg/dL or drug treatment for triglycerides; serum high density lipoprotein (HDL) < 40 mg/dL in men and < 50 mg/dL in women or drug treatment for HDL; blood pressure $\geq$ 130/85 mmHg or drug treatment for elevated blood pressure; and fasting plasma glucose (FPG)
≥ 100 mg/dL or drug treatment for elevated blood glucose (Grundy, Brewer, Cleeman, Smith, & Lenfant, 2004). All of the components of metabolic syndrome were shown to be more common in women with OSA, putting women with OSA at a higher risk of developing cardiovascular disease and diabetes (Theorell-Haglow et al., 2011).

Of the criteria for metabolic syndrome, obesity is perhaps the most recognizable as being related to OSA. As Yu (2011) points out, there appears to be a “bidirectional causality” between OSA and obesity, as illustrated by the interrelated pathophysiology of the two disorders; even modest improvements in weight can lead to improvements in OSA severity. Several studies have illustrated the link between OSA and obesity, including a study that illustrated the relationship between increasing body mass index (BMI) and OSA severity, and another that showed the correlation between weight gain and AHI, while weight loss lessens the severity of OSA.

Impaired fasting glucose and insulin resistance is often associated with obesity. Current research however shows a strong association between OSA and insulin resistance independent of obesity. Most research shows a significant prevalence of OSA in diabetics with estimates of OSA in diabetics ranging from 58-86%. Some studies are suggesting that there may be a dose response relationship between glycemic control and OSA (Pamidi, Aronsohn, & Tasali, 2010). Intermittent hypoxia and sleep fragmentation, hallmarks of OSA, seem to precipitate bursts of sympathetic nervous system activation which can result in increased lipolysis, gluconeogenesis, and glycogenolysis (Lochan, 2011; Yu & Berger, 2011). Counter-regulatory hormones such as growth hormone (GH), glucagon, and cortisol, are also increased in the presence of intermittent hypoxia and recurrent arousals and also from the disruption of the circadian rhythm-controlled hypothalamus-pituitary-adrenal axis (Yu & Berger, 2011). This sympathetic output can also lead
to daytime hypertension that is refractory to medication (Montesi, Bajwa, & Malhotra, 2012; Peppard, Young, Palta, & Skatrud, 2000).

Much evidence exists for the detrimental cardiovascular effects of sleep apnea. In a study published in 2009, Lee et al. found the incidence of undiagnosed OSA in those admitted to hospital for acute myocardial infarction was more than 65%. The prospective study evaluated patients admitted to a tertiary facility with acute MI and subsequent percutaneous intervention (PCI) and found that 65.7% of those patients had an AHI greater than 15. In a separate study, Marin and his colleagues (2005) recruited 264 healthy men, 377 simple snorers to be age and BMI matched with a cohort of men with OSA they were already following. This group included 403 patients with untreated mild-moderate OSA, 235 with severe untreated OSA, and 372 patients with OSA treated with CPAP and found that untreated OSA significantly increases the risk of fatal and non-fatal cardiac events. The bi-directional causal link between obesity and OSA again seems to play a central role in the development of the cardiovascular events that are part of the sequelae of OSA. Excessive adipose tissue predisposes the patient to OSA. OSA subsequently leads to intermittent nighttime hypoxemia and acidosis. This leads to pulmonary arterial hypertension (PAH), which leads to right ventricular (RV) hypertrophy and enlargement, and eventual RV failure. Concurrently, excessive adipose tissue leads to an increase in circulating blood volume, causing an increased left ventricular (LV) stroke volume and increased cardiac output (CO). Increased LV stroke volume and CO lead to LV enlargement, increased LV wall stress, and eccentric LV hypertrophy, which leads to LV systolic and diastolic dysfunction, and eventually LV failure. LV failure increases pulmonary venous hypertension exacerbating the PAH and RV hypertrophy and enlargement, contributing to RV failure (Yu & Berger, 2011). There is also considerable evidence for a direct relationship between OSA and
hypertension. In a prospective study of 709 participants in the Wisconsin Sleep Cohort Study, Peppard et al (2000) demonstrated a dose-response relationship between the severity of OSA and the presence of hypertension. After adjusting for confounding factors including body habitus, cigarette smoking, alcohol use, age, and sex, the researchers found that, compared to individuals with an AHI of zero at baseline, people with mild sleep apnea (AHI of 0.1-4.9) were 42% more likely to have hypertension. Those with moderate OSA (AHI 5.0-14.9) were two times more likely to have hypertension; those with severe OSA (AHI greater than 15.0) were three times more likely to have hypertension. Previous studies using animal models suggest that exposure to intermittent hypoxia, as in OSA, activates the sympathetic nervous system via carotid chemoreceptors. This produces a rise in blood pressure that carries over into wakefulness (Brooks et al, 1997). In addition to the cardiovascular consequences of OSA, neurovascular consequences include an increased risk of stroke and epilepsy (Lochan, 2011).

Though obesity is one of the hallmarks of OSA and appears to be a predisposing factor of OSA, many of the deleterious effects of OSA are present independent of obesity. One recent study (Bhattacharjee et al., 2011) highlighting the pathophysiology of OSA found that various inflammatory pathways are activated by OSA, leading to end organ morbidity. In children, these are the same pathways that appear to be activated by obesity, leading to similar pathology between the obesity and OSA. Various inflammatory cytokines and adipokines, along with CRP, IL-6, TNF-α, leptin, and MRP8/14 are among the initiators of inflammatory pathways, which along with chronic intermittent hypoxia and cortisol lead to a state of chronic inflammation, with the accompanying increases in reactive oxygen species (ROS) and other inflammatory cytokines that lead to endothelial cell dysfunction and atheromatous plaque formation, exacerbating the poor cardiovascular picture that has already been created. Random sample studies in the general
population have suggested that nocturnal breathing disorders are a significant risk for coronary artery diseases (CAD) independent of other risks of CAD. Though the development of coronary artery disease appears to be multifactorial, some studies have shown a dose-response relationship between the severity of the SDB and the severity of the cardiovascular outcomes, the implication being that the cardiovascular outcomes seen in patients with OSA are related to the pathologic processes of OSA.
Diagnosis of Obstructive Sleep Apnea

The gold standard for diagnosis of OSA is polysomnography (PSG) when performed overnight in a Sleep Center with a qualified attendant. PSG is a diagnostic test in which the patient sleeps attached to several devices that record physiologic variables. Abnormal patterns of data recorded can be analyzed to aid in diagnosis of several sleep disorders. The most common indication for PSG is the diagnosis of OSA but other indications include evaluation of restless leg syndrome, re-evaluation of OSA after significant weight loss, and as a post-surgical intervention for OSA to determine the degree of success of the surgery. PSG is also used to titrate the level of pressure required using continuous positive airway pressure (CPAP) in the treatment of OSA. There are no contraindications to PSG.

Standard PSG records data on at least seven channels. The various channels are integrated into a polysomnogram. The first channel measured, an electroencephalogram, identifies stages of sleep according to brain activity. An electrooculogram (EOG) measure eye movement which discriminates between REM and NREM sleep. A chin electromyogram (EMG) is used to detect the muscular hypotonia seen in REM sleep and also can help identify clenching or grinding of teeth. Airflow is also measured in standard PSG. Nasal inserts connected to a pressure transducer detect inspiratory flow. Because these cannot detect mouth breathing, a thermistor is routinely used to detect mouth breathing by detecting alterations in heat exchange. Pulse oximetry is used to determine oxygen saturation. EMG leads spread across the chest and abdomen detect muscle activity and are used to determine respiratory effort. This channel is cross-referenced with other channels such as airflow and O₂ saturation. This can be used to flesh out the nature of the apnea. A one-lead electrocardiogram (ECG) is obtained to
detect arrhythmias during sleep. Lead II alone is used. Other recommended parameters include body positioning and leg EMG (Epstein et al., 2009).

There is some debate presently over the necessity of obtaining a comprehensive full-night sleep study with polysomnography. In 2008, the Centers for Medicare and Medicaid Services (CMS) published a decision memo defining four types of sleep studies. These four types have become generally accepted by the medical community. Type I PSG, also known as attended polysomnography, is the most comprehensive of the four types, and is the reference standard for the other types of PSG. Type II monitors record a minimum of 7 channels including EEG to measure sleep stages so an accurate AHI can be calculated. Type III monitors measure a minimum of 4 channels including ventilation, heart rate, and oxygen saturation. Type IV monitors generally measure only two channels and do not meet the more stringent requirements of other monitors.

Type I and Type II monitors differ only in that Type II devices are used in the patient’s home, without an attendant monitoring sleep. The importance of the definitions of the types of monitors relates to treatment of OSA. Treatment of OSA with CPAP therapy is the currently accepted first line (Lochan, 2011). Prior to this decision memo, CPAP therapy could only be ordered following Type I (in-facility, fully monitored) PSG. Medicare and Medicaid beneficiaries are now able to have CPAP prescribed based on the results of Type II ad Type III, or home monitoring (HM) devices (Center for Medicare and Medicaid Services, 2008). Clinical trials were performed comparing the responses to CPAP of patients identified by either PSG or HM. Patients identified with PSG were not shown to have better responses to CPAP that those identified with HM (Collop & Epstein, 2008).
Home monitoring for OSA, especially with a Type III device, has the advantage of being both more accessible and less invasive than traditional polysomnography. However, HM does not yield as much data. HM records fewer measurements; most notably, in-home monitoring does not record an EEG. As such, it is not possible to tell if a patient is sleeping or not. This makes capturing the epidemiology of OSA slightly dubious, as the diagnostic criteria for OSA is based on the apnea-hypopnea index, which in turn is based on the amount of time the patient spends asleep at night. Clinicians are then left with the choice of estimating the time the patient spends asleep. This can lead to the clinical dilemma that is capturing too many patients vs. underestimating the severity of OSA. To ease the problems associated with this dilemma, clinicians have developed the respiratory disturbance index (RDI): the number of respiratory disturbances divided by the length of the study. Because the RDI does not capture the true AHI, clinicians run the risk of underestimating the severity of OSA (Collop & Epstein, 2008).
Identification and Treatment

Because the characteristics of the metabolic syndrome and the risk factors for OSA mirror each other, some patients are more easily identified as appropriate for PSG than others. Given the bidirectional causality of OSA and obesity, overweight patients can be identified as needing further screening. In addition to waist size, neck circumference greater than 17 inches can identify patients at greater risk for OSA (Epstein et al., 2009). Patients who snore are also at an increased risk for OSA. The constellation of obesity, snoring, and excessive daytime sleepiness can help to guide a clinician toward an evaluation of OSA. OSA is still underdiagnosed by clinicians and under-reported by patients as sleep hygiene is not a part of the normal history and counseling. As Yu points out, the rise in obesity has not been mirrored by a rise in diagnosed OSA. This suggests that clinicians are not recognizing OSA. While obesity, observed apneas, and excessive daytime sleepiness are more obvious indications for a sleep study, hypertension, dyslipidemia, and glucose intolerance are less obvious reasons for polysomnography. The most discriminating self-administered screen for excessive daytime sleepiness is the Epworth Sleepiness Scale (ESS) (see appendix A). The ESS asks the patient to rate his or her propensity to fall asleep in different situations. Point values are then assigned to each situation and the scale can be used to determine the appropriateness of a sleep study.

Polysomnography, regardless of the type of device used in the study, is used to determine the appropriateness of therapy. The gold-standard of treatment of OSA in adults continues to be the use of continuous positive airway pressure (CPAP). CPAP is an air compressor with an attached mask applied to the patient’s face that, as the name implies, provides continuous positive pressure to the airway and acts as a “physiologic splint” to keep the airway from collapsing (Lochan, 2011) during sleep. As previously mentioned, the obstruction in OSA is a
result of the negative pressure in the airway from breathing overcoming the positive pressure supplied by the anatomy of the oropharynx. During sleep, the natural atonia of the muscles of the oropharynx combined with the pathological deposition of adipose tissue into those same muscles, create a situation in which the airway collapses. The work of breathing however continues against that obstruction resulting in the apnea, or cessation of breathing (Lochan, 2011). CPAP supplies a continuous column of air that counteracts the negative pressure and keeps the airway patent. CPAP therapy is initiated after a sleep study with PSG to determine the need for therapy. A second overnight session at a sleep center is necessary to establish the proper level of pressure required to achieve the physiologic splint.

CPAP therapy continues to be the most effective therapy for the treatment of OSA and has been shown to decrease the number of apneic and hypopneic events. Furthermore, CPAP therapy has been shown to decrease daytime sleepiness (Yu & Berger, 2011) while raising levels of HDL-C and lowering total cholesterol. Therapy with CPAP has also been shown to decrease visceral adiposity and reduce weight, possibly mediated by a decrease in serum leptin. Effective treatment with CPAP can also lead to the resolution of pharmacologically intractable hypertension (Lochan, 2011).

New frontiers are constantly being explored in the area of OSA treatment. Auto-titrating positive airway pressure (APAP) is a device that detects episodes of airway resistance and provides increasing pressure until the resistance is overcome. The pressure automatically declines as the apneic event resolves. CPAP remains the standard of care for OSA—there have been no head-to-head randomized clinical trials comparing CPAP and APAP, though APAP is increasingly used as nightly therapy for OSA or to determine the appropriate level of pressure for patients to use with a CPAP device. Weight loss has also been shown to reduce the frequency of
apneic and hyponeic events. Up to 70% of patients applying for bariatric surgery have OSA and OSA is commonly being listed as the co-morbidity when preparing for bariatric surgery. Oral appliances have been shown to be effective in treating OSA and tracheostomy is the definitive, if invasive, treatment.

Several recent studies have confirmed the benefits of CPAP therapy in the treatment of the metabolic and cardiovascular sequelae of OSA. Sharma et al. (2011) designed a double-blind, placebo controlled clinical trial in which patients were assigned to either CPAP or sham CPAP therapy for three months. After the three months of treatment, the patients underwent a one month washout period and then switched to the other intervention for three months. The authors believed that one month would be sufficient for any positive effects from CPAP therapy to leave the patient. Although it was a small study, the investigators found significant mean decreases in both systolic and diastolic blood pressures, decreases in serum total cholesterol, and declines in glycated hemoglobin in those in the CPAP group versus the sham CPAP group. Additionally, the metabolic syndrome was reversed in 13% of those in the CPAP group compared to 1% of patients in the sham CPAP group. It is interesting to note that the reversal of metabolic syndrome in patients in the CPAP group was associated with significant amelioration of only one of the components of metabolic syndrome, and which component was reversed was not consistent from patient to patient.
Even as the benefits of CPAP therapy continue to be elucidated, adherence to CPAP therapy remains poor, with rates of adherence to treatment between 29% and 83%. Adherence to therapy is defined as CPAP use of at least four hours per night for 70% of nights. CPAP therapy has been shown to be effective, both in terms of the positive impact on the disease process, as well as the costs associated with long term treatment (Olsen, Smith, Oei, & Douglas, 2012). CPAP units today include instruments to record the time per night the patient spends at the correct pressure, providing objective measures of compliance (Catcheside, 2010). So what are the factors that contribute to CPAP adherence, and can adherence be positively impacted? The literature regarding patient compliance with therapy has been evolving over the past several years. The focus of research has gradually shifted from disease specific metrics that can explain variances in CPAP compliance such as improvement in excessive daytime sleepiness, or CPAP treatment side effects such as leaky masks or dry skin, towards research that explores the psychological aspects of acceptance of and compliance with treatment. Side effects of CPAP therapy are often cited as reasons for discontinuing treatment. However, treating the side effects does not produce significant increases in compliance (Aloia, Arnedt, Stepnowsky, Hecht, & Borrelli, 2005). This research has led to potentially promising applications of the patient centered intervention, motivational interviewing (MI).

Some of the difficulties with adherence to CPAP treatment can certainly be explained by the lack of objective evidence that treatment is working. Currently, there is no biomarker for severity of disease or number to achieve as a goal making tracking the progression of the disease or response to treatment more of a challenge. Several biomarkers have been proposed, including C-reactive protein (CRP), tumor necrosis factor-α (TNF-α), and interleukin-6 (IL-6), though
none of these has sufficient sensitivity to function as a viable screening test. If an objective biomarker of OSA could be identified, measuring disease severity and response to treatment would be dramatically easier, possibly removing one barrier to treatment and improving adherence to CPAP therapy (Montesi et al., 2012).

Though identifying a potential biomarker for OSA screening would be an important advancement, adequate and appropriate treatment of those already identified as having OSA with a documented AHI by polysomnography remains challenging. Adherence to CPAP is notoriously low. A 2004 meta-analysis of 569 studies over fifty years regarding adherence to medical therapies compared adherence to therapy for several different diseases and found that adherence to therapy was lowest for sleep disorders (DiMatteo). Diseases included in the meta-analysis were HIV, arthritis, gastrointestinal disorders, cancer, seizures/brain disorders, genitourinary disorders and STDs, skin disorders, cardiovascular diseases, ENT and mouth disorders, blood disorders (not leukemia), OB/GYN diseases, infectious diseases, eye disorders, end-stage renal disease, pulmonary diseases, diabetes, and sleep disorders. Adherence for all disorders included in the study ranged from 4.6% to 100%. The median adherence value was 76% while the average adherence to therapy was 75.2%. The meta-analysis revealed that adherence was highest in those disorders that required pharmacologic management as opposed to those disorders that require a behavioral change. The analysis showed that patients with more resources, such as education and income, achieved better adherence to therapy, though adherence was not simply a function of basic demographic information.

CPAP therapy seems to be a combination of two types of therapies described in the study; while treatment is not with a scheduled medication; therapy consists of regimented behavioral change that requires adherence for maximum benefit.
While compliance with CPAP therapy can be improved with benzodiazepines (Park et al., 2011) and education of the patient and bed partner (Yu & Berger, 2011), questions still remain about how to positively impact the progression of the disease. One of the earliest studies regarding CPAP use was published in 1997 by Weaver and Kribbs et al. The researchers covertly recorded the CPAP usage of 32 patients recently diagnosed with OSA and prescribed CPAP therapy. None of the patients had used CPAP previously. Data was recorded over the first 9 weeks of treatment. Analysis of the night-to-night patterns revealed two distinct groups of users in a bimodal distribution that the authors labeled “consistent users” and “intermittent users.” Fifty-three percent of users were termed consistent users and applied CPAP for more than 90% of nights averaging 6.21 ± 1.21 hours per night. The remaining 47% of users were termed intermittent users and exhibited a wide variability in nightly use ranging from 2-79% of nights. Average nightly use was 3.45 ± 1.94 hours. Additionally, it was found that those patients who skipped the most nights of CPAP use also applied CPAP for the shortest duration when used.

The researchers next attempted to determine when in the course of treatment patterns of use were established. An ANOVA performed on the first 14 days of treatment of the mean hours of use yielded significant differences between consistent and intermittent users. Intermittent users showed a significant difference in the mean minutes of CPAP use over the first 14 days of treatment. Consistent users did not demonstrate these decreased patterns of use. Additionally, on the first day of treatment, the majority of patients in both groups used CPAP for more than 6 hours; but over the next three days, proportionately more intermittent users skipped CPAP and the duration of use per night declined, resulting in significant differences in use between the two groups. This pattern of differential use between the two groups was maintained over the rest of
the study period and suggests that patterns of increased skipping and decreased nightly use were established early in treatment. Consistent and intermittent users did not differ significantly in demographics, physiological characteristics, chief complaint, pretreatment, or level of CPAP pressure, but at 1 month of treatment, consistent users reported fewer symptoms of OSA than intermittent users.

Weaver and Kribbs et al. were the first researchers to try and identify patterns of CPAP use among new users and were able to classify users in the study as consistent or intermittent. The idea that patterns of use are established early in treatment was picked back up a decade later by Aloia, Arnedt, and Millman (2007), who recreated and expanded the previous Weaver and Kribbs et al. study (1997) and further demonstrated that patterns of CPAP adherence are established in the first few days of treatment. In their study, adherence to CPAP therapy was reported as the total number of hours used according to the prescription for a 24-hour period. The larger study consisted of 140 moderate to severe OSA patients. Adherence to therapy was monitored by internal microprocessors in the CPAP machine and was reported as the total number of hours CPAP was used at the prescribed pressure per night. Participants were considered “consistent users” if they used CPAP correctly for an average of 6-7 days per week for the first six months. “Intermittent users” were those who used CPAP for less than 6 days per week for six months. The researchers reported that approximately one half of patients were classified as consistent users and the other half as intermittent users, consistent with the earlier study. The researchers further report that the patterns of consistency of use can be demonstrated in the first days of CPAP therapy, also consistent with the earlier study. Post-hoc univariate ANOVA tests indicated that treatment was highest among consistent users on every night of treatment over the first 14 days of treatment. Consistent CPAP users were found to use CPAP
more nights and more hours per night than intermittent users from the first day of treatment. A potential confounder of the results of the study is that both Bi-PAP and CPAP were used. More users of Bi-PAP were classified as consistent users than intermittent users. While this finding could illustrate how different technologies impact adherence, it is unclear if the inclusion of Bi-PAP in this study confounds the results, or if other factors contribute more heavily to consistent use of positive airway pressure. The authors suggest that further randomized controlled trials are needed to compare outcomes using Bi-PAP and CPAP.

If decisions regarding adherence to CPAP therapy are made early in that therapy, it seems, then, that early in CPAP therapy would be an ideal place to begin to impact the prognosis of OSA. Before clinicians can begin to positively affect adherence, it is important to have an understanding of some of the reasons patients either choose to adhere to therapy or not adhere. An important early attempt to understand the determinants of CPAP compliance was a study by Stepnowsky et al. published in 2002. This small study consisted of 51 consecutive OSA patients at a VA pulmonary clinic. Prior studies had categorized determinants of CPAP adherence into one of three general categories: patient/demographic, disease related, and CPAP related, but few determinants had been found. The researchers hypothesized that, as CPAP is an aid and not a cure, and that because a significant lifestyle change on the part of the patient and family is necessary, human factors would be important in determining CPAP compliance. The researchers therefore hypothesized that two models of behavioral change, social cognitive theory (SCT) and the transtheoretical model (TM), would account for the human factors responsible for the variance in CPAP compliance. SCT and TM scales were developed for the study that would attempt to determine if any of the variance in CPAP adherence could be attributed to those variables. Covariates in the analysis included age, BMI, AHI, CPAP pressure, and daytime
sleepiness. All of the covariates had been found to affect compliance in previous studies. Questionnaires were distributed to participants at the time of CPAP fitting, 1 week post-fitting, and 1 month post fitting. Analysis of the data revealed that neither the SCT variables nor the TM variables measured on the day of CPAP fitting were associated with greater compliance to therapy at 1 month post-fitting. Regression analysis of the results of the one week post-fitting questionnaire, however, revealed that SCT variables accounted for an adjusted total of 31% of the variance in CPAP compliance and TM variables accounted for an adjusted total of 24% of the variance. At one month post-fitting, SCT variables accounted for an adjusted total of 40% of the variance in CPAP compliance indicating that the SCT variables were highly associated with CPAP compliance at one month. Similarly, TM variables at one month post-fitting accounted for an adjusted total of 33% of the variance in CPAP compliance also indicating that TM variables were highly associated with compliance at 1 month. The results further suggest that decisions regarding acceptance of and compliance with CPAP therapy are made early in the course of therapy, but after the patient has had experience with CPAP therapy. The authors suggest that CPAP compliance could possibly be increased if clinicians made an effort to augment the variables associated with SCT and TM.

One intervention currently under study is motivational interviewing. Motivational interviewing (MI) is based on the stages of change model in which patients are engaged in the decision making process in an attempt to find reasons to change that have personal meaning (Berkowitz & Johansen, 2012). MI was first developed as technique to help treat alcoholism, but has been successfully adapted to assist in smoking cessation, weight loss, and medication adherence. MI differs from the traditional paternalistic view of health care as “advice giving”; patients do not always like advice if it is perceived as “being told what to do” (Britt, Hudson, &
Blampied, 2004). MI focuses on establishing the intervention as something in which the patient is invested. Motivation, therefore, is a “state of readiness for change” and not a personality trait. MI is seen as being particularly useful for patients who are ambivalent about changing their behavior. The interventions in MI are more persuasive and supportive than coercive and argumentative. The goals are to strengthen the patient’s intrinsic motivation for change so that it comes from within the patient and not from the provider. Rubak et al. (2005) attempted a meta-analysis of studies of the effectiveness of MI in the healthcare setting. Starting with the assumption that MI would be more effective in therapies that require some behavioral change. The researchers found 72 studies over MI and behavioral change. They only included studies in the meta-analysis that compared outcomes of MI techniques with a control group of patients receiving traditional advice giving techniques. To be considered as having an effect on outcome, the recorded effect had to be statistically significant.

Motivational interviewing was shown to have an effect in 74% of the studies included in the meta-analysis. No studies showed MI to be harmful or have any adverse effects. Effects were more likely to be seen as the number of encounters increased. Forty percent of studies with one counseling session showed an effect, whereas 87% of studies with more than 5 encounters showed an effect. Prolonged follow-up also increased the likelihood of the intervention having an effect. The authors believe that, because MI showed a positive in about 75% of the studies included in the meta-analysis, interventions using MI techniques should not be limited to a small group of select patients, but can be applied to a broader group of disorders where behavior plays a role in the extent of the consequences. Especially viewed in the light of the finding that MI interventions did not have any adverse effects, the intervention seems especially helpful when applied to CPAP adherence.
In contrast to the study by Rubak et al., a meta-analysis by Knight et al. (2006) of 51 relevant articles found that though the majority of studies about MI did show positive results, but many problems exist with the research: small sample sizes, lack of power, use of multiple and different outcomes, poorly validated questionnaires, and poorly-defined therapy and training all confound the results of the various studies of the effects of MI techniques. The authors conducted a literature review and meta-analysis of the available research in an attempt to determine the extent to which MI techniques have been used in different health care settings, evaluate the effectiveness of MI techniques, evaluate the research quality, and identify areas for further research. The authors included non-randomized and non-controlled studies in the meta-analysis as there were only a small number of randomized controlled trials (RCTs) to consider. Of the studies included in the analysis, only 2 were found to be adequately powered RCTs. Several pilot studies were also included in the analysis. In some of the studies included, it was unclear whether MI was given as a full intervention or a brief intervention. Only one of the studies included an assessment of the skill level of the practitioner. The researchers ultimately concluded that the internal validity of the RCTs in the area of MI is too low and the evidence for MI does not justify its widespread use.

The early research into CPAP adherence suggests that patients’ decisions regarding acceptance and adherence to therapy are made within the first days of treatment and patients can be classified as consistent or intermittent users based on their patterns of use. It seems then, that the first few days of treatment would be an appropriate place to direct therapy. Despite the lack of consensus on the efficacy of MI, it still is widely used in practice. MI is viewed as a way to augment the patient’s intrinsic desire for change. In this way, motivation is viewed as a modifiable risk factor for CPAP adherence, not as a static component of the patient’s personality.
Approaching the problem of adherence to CPAP from a motivational standpoint, Aloia et al. (2005) attempted to determine whether MI could positively affect adherence to CPAP therapy. Taking as a starting point the results of previous studies that showed that patient attitudes about their disease and treatment was a stronger predictor of adherence to treatment than specifics about the disease, and that treating adverse effects of CPAP therapy produced only minor improvements in adherence, the researchers attempted to discern if adherence could be positively affected by MI techniques. Two behavior-change theories, the Transtheoretical Model (TM) and Social Cognitive Theory (SCT) were used. TM places the patient along a continuum of readiness for change, while SCT is more readily applied to patients who are ready to change, and focuses more on problem solving, coping skills, goal setting, self-efficacy, and management of outcome expectations. Of these measures, self-efficacy has been found to be a major determinant of behavioral change and long-term adherence to a prescribed therapy. Building on the earlier research of Stepnowsky et al., the researchers recruited ninety-eight patients with moderate to severe OSA into a longitudinal prospective study. Measurements of the behavior-change principles, specifically readiness for change, decisional balance, and self-efficacy, were taken at baseline and periodically for six months. Adherence was monitored without participants in the study being made aware that adherence was the primary outcome. Several psychological measures that factor into MI such as readiness and self-efficacy, or confidence, were strong predictors of adherence to treatment at 1 week, and 3 and 6 months. These behavior-change principles were compared to disease specific factors such as improvement in daytime sleepiness or treating the side effects of CPAP therapy. Regression analysis of the TM and SCT data at baseline failed to predict adherence at 6 months. When data collected at one week were used in two regression analyses to predict adherence at 6 months, a different picture emerged. The first
analysis was employed to determine the effects of the behavioral change principles on adherence at 6 months, and found that the overall regression accounted for 23.2% of the variance in adherence at 6 months. A second regression analysis was then done in two steps to determine if the behavioral change principles could be used to predict adherence at 6 months over and above adherence at one week. The overall regression accounted for 56.4% of the variance in 6 month adherence, however the second step revealed that CPAP use at week 1 accounted for 52.2% of the total variance in adherence at 6 months and the behavioral change measures did not account for significantly more of the variance. Using 3 month SCT and TM data to predicting 6 month adherence revealed similar results. Two regression analyses were again used. In the first analysis, TM and SCT measures at 3 month were used to predict adherence at 6 months. These measures accounted for a total of 41.5% of the variance in 6 month adherence. A second analysis was then performed to determine the predictive value of the behavioral change variables over and above adherence at 3 months. The regression analysis could account for 79.4% of the total variance in adherence at 6 months, however CPAP use at 3 months accounted for 77.9% of the total variance with the behavioral change principles not contributing significantly more to overall adherence. As the research had demonstrated that SCT and TM measures were not associated with significant predictive value over and above objective measures of adherence at a given point, the authors employed a final regression analysis to determine if SCT and TM measures taken at 6 months could be used to predict current use over and above self-reported CPAP at the same time point. In step 1 of the analysis, reported CPAP use at 6 months accounted for 48.5% of the variance in adherence. In step 2, SCT and TM measures contributed an additional 9.6% of the variance in objectively measured adherence. Self-efficacy proved to be the only SCT and TM measure that significantly predicted objective use at 6 months and was
such a strong predictor of adherence in all regression models that the authors posit it may be more than a “surrogate marker of adherence” and that impacting self-efficacy may in itself impact adherence. The results of the regression analysis further illustrate that the relationship between SCT and TM measures and CPAP use increases with CPAP experience.

Another proposed model to predict adherence to CPAP therapy is the health belief model (HBM). CPAP treatment requires a major commitment on the part of the patient and comes with considerable lifestyle modifications. Patients often experienced side-effects with the mask, and compliance with therapy suffered. However the evidence from studies that side effects of treatment contribute significantly to non-adherence, or that treatment of the side-effects of therapy improve compliance is inconsistent. Additionally, studies suggest that objective measures of severity of disease such as the AHI do not always correlate with the patient’s subjective reported symptoms. This disconnect between the patient’s subjective symptoms and objective measures of disease burden indicates that the patient’s subjective view of the problem may not reflect the true severity of the disease or the need for treatment (Olsen, Smith, Oei, & Douglas, 2008). This led researchers to propose interventions based on techniques using HBM. Health belief models suggest that a patient’s willingness to accept therapy is based on the how much the patient believes he or she is ill, or susceptible to illness, the patient’s beliefs about the benefits of the prescribed therapy, and how much the perceived benefits of treatment outweigh the perceived risks (Tyrrell, Poulet, Pe Pin, & Veale, 2006). As in SCT and TM models, self-efficacy plays a major role in decisions regarding treatment in HBM.

Tyrrell et al. (2006) conducted a preliminary study of factors affective patients’ acceptance of CPAP therapy based on the health belief model. The researchers developed questions for the study based on previous HBM studies, but focused the details on 1) the
patient’s understanding and experience of his or her OSA, 2) the patient’s understanding and experience with CPAP therapy, and 3) factors that led the patient to discontinue CPAP therapy. Twenty patients who had a diagnosis of OSA and had discontinued CPAP therapy were recruited for the study which was observational in nature. Nine patients were ultimately included. Eight were male and 1 was female.

The interviews revealed that the patients had a highly variable understanding of the nature of OSA. Four of the 9 were unclear about the mechanisms of the sleep disorder. All 9 mentioned sleep disturbance and fatigue as consequences of OSA, but only 1 patient mentioned life threatening risk. Four thought that OSA could be cured and 5 patients were not concerned about OSA as a disease after quitting therapy. Despite receiving education about CPAP therapy, the patients’ understanding of therapy was also highly variable. Four patients talked about difficulty with treatment and four mentioned fatigue as a consequence of CPAP therapy. Three patients thought CPAP would be a cure for OSA, and only two patients said they felt better after treatment. Decisions to stop CPAP therapy appeared to be more uniform. Seven patients said they discontinued therapy because of negative experiences despite family encouragement to continue. All 9 patients had other health problems. Five patients said they felt better after discontinuing therapy and 2 said they felt liberated.

Though the study was limited to 9 patients, the authors believe that the patients’ vague understanding of OSA and CPAP therapy indicated that these subjective factors may be pertinent to decisions to stop therapy. The authors further propose that the health belief model may be an important framework in which to discuss treatment adherence. Patients were able to give a wide variety of concrete reasons they stopped CPAP therapy, but were unable to give more than vague benefits to treatment. A subjective analysis of the cost-benefit ratio appears to play a large role.
in these patients’ decisions to discontinue treatment. Patients in this study also were less likely to view themselves as ill, indicating that CPAP therapy may be more adhered to by patients who view themselves as having a disorder that requires treatment. The authors conclude that as with other forms of chronic disease requiring long term treatment, more attention should be paid to psychological aspects.

A second study of the health belief model in relationship to CPAP adherence was undertaken by Olsen et al. in 2008. The authors proposed that HBM could be used as framework on which to begin to understand patients’ decisions to accept and continue CPAP therapy, and the aim of the study was to determine if HBM constructs could be used to predict adherence early in treatment. Seventy-seven consecutive patients were recruited for study after diagnosis of OSA but before treatment was initiated. Health belief model constructs included in the analysis were self-efficacy, perceived risk, functional outcomes (a measure of perceived severity), and outcome expectancies (a measure of perceived benefits). The questionnaire consisted of the Epworth Sleepiness Scale (appendix A), questions regarding perceived quality of life with OSA, which attempted to uncover patients’ perceived severity of illness, and measures of patients’ perceived self-efficacy relating to CPAP therapy. Patients also completed a Depression Anxiety Stress Scales questionnaire which measured patients’ depression and anxiety. Compliance to CPAP therapy was measured at 4 months.

Adherence data at the 4 month follow-up indicated that 14% did not accept treatment from the start of therapy, 27% had meter readings of 1.0-4.5 hours per night, 45% had meter readings of 4.5-8.0 hours per night, and 10% had meter readings of 8.0-11.1 hours per night. Regression analyses were performed to determine the effects of the HBM metrics of risk, outcome expectancy, self-efficacy, and functional outcomes on the adherence data. The four
measures explained a total of 21.8% of the variance in CPAP therapy compliance, which was significant. When examined individually, risk, outcome expectancy, and functional outcomes all explained a different significant portion of the variance in compliance, while self-efficacy did not account for a significant amount of the variance. Overall, significant relationships were found between adherence to CPAP therapy and the HBM constructs measured before initiating therapy. The ESS score was not found to be a significant predictor of CPAP adherence. The authors believe that the study supports the value of using HBM constructs in the early prediction of CPAP adherence, though they acknowledge that the small sample size makes predictions about the power of the study more problematic. However, they posit that the results of the study support the assertion that the psychological constructs measured in the study do affect early decisions regarding CPAP therapy, and that early identification of the HBM constructs measured in the study could lead to assistance in overcoming the barriers to acceptance of treatment.
Discussion

It is clear that adherence to any therapy is difficult to achieve, regardless of the disorder the therapy is intended to treat. MI, which incorporates elements of SCT and TM theory, has been posited as an alternative to the traditional “advice giving” interventions. MI has had some success in areas such as smoking and alcohol cessation and weight loss. It is less clear if MI techniques are effective for improving adherence to CPAP therapy in OSA. Studies indicate that patterns of acceptance and adherence to CPAP therapy are established within the first few days of treatment. Also demonstrated by the research is the idea that the only consistent indicator of CPAP compliance is experience with CPAP. Put in a different way, the best way to achieve and maintain compliance with CPAP therapy is to use CPAP therapy. Several studies demonstrate that baseline patterns of use at the time of CPAP fitting and pressure titration do not predict consistent use at 1, 3, or 6 months. However patterns of use after 1 week of treatment are predictive of future use; patients who were more adherent to therapy in the first week of treatment were more likely to be adherent to therapy at 3 and 6 months. SCT and TM variables were shown to be predictive of adherence at one week post-fitting, but were not shown to be predictive of compliance at 6 months over and above the variance in adherence accounted for by current use. Similarly measures of HBM constructs early in therapy were predictive of significant portions of the variance in CPAP adherence at 4 months. These findings suggest that the ideal time to positively impact adherence is early in the course of therapy.

Some of the difficulty in predicting compliance may be related to our poor understanding of the nature of adherence. As Berkowitz and Johansen (2012) suggest, our theoretical understanding of non-adherence is not fully realized, and that MI and the stages of change model, does not fully address the causes of non-adherence. What is clear from the research is
that there is a dearth of quality randomized controlled trials comparing MI interventions to traditional interventions. Well-designed studies with appropriate sample sized, well validated questionnaires, and rigorous methodology would add much to the field of OSA treatment specifically and perhaps advance our understanding of adherence in general.

One of the more appealing aspects of MI is that intervention techniques involve a dialogue with the patient. The clinician-patient interaction is more of a clinician guided journey the patient takes than a lecture by the clinician about what the patient should or should not do. The patient is allowed to come to the appropriate decision without feeling pressured into a therapy he or she does not want. By allowing the patient to be the focus of the intervention and making the decisions regarding treatment, the patient is more empowered and motivated to a positive outcome. Motivation can then be viewed as a modifiable risk factor for adherence rather than a static personality trait to be combatted.
Conclusions

Even as our understanding of the pathophysiology of OSA continues to improve and its long-term sequelae elucidated, the disorder still remains under-reported and under-diagnosed. If decisions regarding compliance with CPAP treatment are made in the first few days of treatment, clinicians need to make more of an effort in the first few days of treatment to ensure compliance. Motivational interviewing offers an opportunity to empower the patient and make him or her a partner in treatment. As previously described, MI interventions depend on the patient to come to the desired conclusion on his or her own terms. As the creator of the plan of care, the patient would be more invested in the outcome and therefore personally responsible if treatment is not followed through. Motivation becomes a modifiable factor in CPAP treatment. Impacting motivation for successful treatment can possibly significantly impact the disorder.

Long-term treatments for chronic diseases require long-term commitments to the goals of therapy. Are clinicians branding CPAP therapy in the same way that they are branding metformin or insulin therapy for diabetes mellitus, or inhaled corticosteroid treatment in asthma, as potentially life-prolonging and life-saving treatments? As evidenced by the lack of compliance among OSA patients, it is clear that more needs to be done to impact morbidity and mortality from this disorder. More and better research into the nature of non-adherence needs to be conducted if we are to make positive strides to improve morbidity and mortality related to obstructive sleep apnea.
References


Catcheside, P. G. (2010). Predictors of continuous positive airway pressure adherence. F1000 Medicine Reports, 2. doi:10.3410/m2-70


Appendix A

Epworth Sleepiness Scale

Name: _____________________________________ Today's date: _________________

Your age (Yrs): _______________ Your sex (Male = M, Female = F): ________

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just
tired?

This refers to your usual way of life in recent times.

Even if you haven’t done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation:

0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

*It is important that you answer each question as best you can.*

<table>
<thead>
<tr>
<th>Situation</th>
<th>Chance of Dozing (0-3)</th>
</tr>
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<tbody>
<tr>
<td>Sitting and reading</td>
<td></td>
</tr>
<tr>
<td>Watching TV</td>
<td></td>
</tr>
<tr>
<td>Sitting, inactive in a public place (e.g. a theatre or a meeting)</td>
<td></td>
</tr>
<tr>
<td>As a passenger in a car for an hour without a break</td>
<td></td>
</tr>
<tr>
<td>Lying down to rest in the afternoon when circumstances permit</td>
<td></td>
</tr>
<tr>
<td>Sitting and talking to someone</td>
<td></td>
</tr>
<tr>
<td>Sitting quietly after a lunch without alcohol</td>
<td></td>
</tr>
<tr>
<td>In a car, while stopped for a few minutes in the traffic</td>
<td></td>
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THANK YOU FOR YOUR COOPERATION

M.W. Johns 1990-97
Abstract

Objective: The purpose of the present clinical analysis is to review the epidemiology, pathophysiology, consequences, and treatment of obstructive sleep apnea (OSA). Motivational interviewing was posited as a promising intervention to improve adherence to therapy. Methods: A literature search was undertaken using PubMed. A total of 56 relevant articles were found using the search terms “obstructive sleep apnea,” “motivational interviewing,” and “obstructive sleep apnea prognosis.” Some of the studies included in the literature review were preliminary studies and as such did not meet the strictest level of scholarship. Results: The literature review revealed that, though motivational interviewing (MI) was effective in impacting prognosis in some studies, it less so in others. Conclusion: MI has been posited as a technique to positively impact prognosis in OSA. The literature shows that the technique has promise, but more and better studies are required.