MESSAGE FRAMING AS A PREDICTOR OF ADHERENCE TO CONTINUOUS
POSITIVE AIRWAY THERAPY

DISSERTATION

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ABSTRACT

Sleep is essential to optimal health and performance. Yet sleep deprivation is endemic in Western societies with most individuals getting less than seven hours of sleep per night. The consequences of either acute or chronic sleep deprivation include altered alertness, impaired concentration, and delayed reaction times that can result in daytime somnolence, cognitive impairment, and motor vehicle accidents. While once considered part of the normal aging process, daytime sleepiness can also indicate more serious health problems. Still, sleep disorders frequently go unrecognized and untreated.

Sleep disordered breathing (SDB) is a family of disorders characterized by abnormalities in either the quality or quantity of respirations during sleep. Approximately 5% of the general population and 30% of those with cardiovascular disease (CVD) have some type of sleep disorder. SDB can be classified as either those who “cannot breathe” or those who “will not breathe.”

Most prevalent of the SDB disorders, obstructive sleep apnea (OSA) depicts the “cannot breathe” patient whose pharyngeal airway collapses during sleep. The thoraco-abdominal muscles continue the effort of breathing, but airflow cannot pass through the upper airway obstruction, resulting in arterial hypoxemia and hypercapnia and neurohormonal (NH) stimulation. Apnea ends
when the patient is briefly aroused, restoring upper airway muscle tone, thus relieving the obstruction. Effective breathing resumes. Fortunately OSA can be treated, resulting in improved sleep quality, reduced sleepiness, lower blood pressure and reduced cardiovascular mortality, just to name a few. Unfortunately, to be efficacious, treatment of OSA requires significant behavioral adaptation and lifelong commitment to its use.

Continuous positive airway pressure (CPAP) is the gold standard for treating OSA. By acting as a pneumatic splint, CPAP essentially mitigates many of the acute physiologic responses to OSA. Just 4 hours of CPAP therapy can provide benefit in sleepiness, snoring, blood pressure, and cognitive functioning with carry-over effects that continue for 3-4 hours. Thus, using CPAP for half the night has advantages for the remainder of that night plus the following day.

CPAP treatment, however, is associated with suboptimal and variable rates of adherence. Importantly, adherence rates for CPAP use are established quickly, often within the first week of therapy, and are not easily altered after that initial exposure. Consequently, it is imperative to develop strategies to enhance adherence. Despite technological advances and device-related interventions, poor adherence remains an ongoing issue. To date, no reliable variables have been identified that can consistently predict who will or will not use CPAP prior to the initiation of treatment.

Adherence requires decisions to be made about prescribed therapies – specifically whether the advice given will be followed or not. Cognitive functioning involves the ability to reason, understand and learn and is an important
consideration for any type of decision-making. Yet impairments in cognitive functioning are quite common with sleep deprivation, resulting in memory, attention, and global cognitive deficits. Thus, cognitive dysfunction has pathological and behavioral consequences for decision-making and adherence.

How information is presented also provides a vital opportunity to persuade and motivate patients and has great implications for education, adherence, and outcomes. Rhetoric may be packaged so that choices are stated in different ways, resulting in markedly different decisions being made. When logically equivalent choices are intentionally worded in order to facilitate some interpretation while filtering out others, a framing effect is observed. For example, a positive message framing effect occurs when the description of possible options for a decision is worded in terms of gains (using a positive frame format), rather than losses (using a negative frame format), thereby eliciting systematically different choices.

This dissertation examines the impact of positive or negative educational messages about CPAP on 30-day adherence to the therapy. Patients with a history of CVD, who were newly diagnosed with OSA, were enrolled at the time of their second sleep study, prior to any personal experience with CPAP. In addition to the standard information given by sleep specialists, participants were randomized to receive supplemental education about CPAP, from either positive or negative framing formats. A number of physical, psychosocial, and disease severity variables were examined at baseline and after 30 days of home CPAP
use. Between-group comparisons were made based upon adherence to CPAP and by group assignment.

From a neurohormonal (NH) perspective, Chapter 1 discusses cognitive dysfunction and adherence in patients with SDB and heart failure, the final common pathway for all CVD. Both chronic conditions have common signs and symptoms of fatigue, reduced attention spans, memory deficits, and excessive sleepiness. Whether discussing treatment of heart failure or OSA, blocking NH stimulation is the main target of therapy. However, key to NH blockade is adherence to the prescribed therapies, whether medications, CPAP, or both. Failure to take medications as directed or to use CPAP at least 4 hours per night results in inadequate NH blockade, leading to disease progression, worsening symptoms, and poor outcomes. Specifically, this chapter proposes a NH synergism and pathological link between OSA and heart failure that may explain cognitive impairments, altered decision-making, and suboptimal adherence in this population. A model depicting these relationships is provided.

Predicting who will or will not use CPAP is a clinically significant question. Chapter 2 examines select baseline demographic, psychosocial, and disease severity variables that have been found to be predictive of CPAP adherence by some, but not all, researchers. Findings of this study confirm that none of those variables, when measured at baseline, were predictive of 30-day adherence to CPAP. However, in post hoc analysis, using CPAP for 4 or more hours the first night strongly predicted 30-day adherence, expanding the clinical definition for and implication of early patient follow-up. Importantly for this dissertation
research, educational messages about CPAP also affected adherence, a finding that is discussed in greater detail in Chapter 4.

Detailed results on the impact of message framing on 30-day adherence to CPAP are presented in Chapter 3 and reveal that CPAP use was significantly impacted by message framing. In particular, negative message framing, emphasizing the negative consequences of untreated OSA, was strongly associated with and predictive of CPAP use at 30 days. In a linear model of adherence, self-efficacy when measured at 30 days, rather than at baseline, demonstrated the most influence on CPAP adherence. Higher self-efficacy was found in those with using CPAP as directed and in those randomized to negative message framing. Additionally, improvements in sleepiness, self-efficacy and depression were seen for the entire sample between baseline and 30 days, regardless of CPAP use or group assignment.

The final chapter summarizes the key findings of this dissertation and provides implications for clinical practice and opportunities for future research. The NH model presented in Chapter 1 is revised to include the variables from this study that were shown to impact adherence to CPAP: message framing, self-efficacy, and first night use.
DEDICATION

Dedicated to my children, Robert and Amanda,

my granddaughters, Ahnna and Kaia,

and to Bill, the love of my life.

Being deeply loved by someone gives you strength;
loving someone deeply gives you courage.

(Lao Tzo)

I am forever grateful for and blessed by the strength, courage, love and joy that have resulted from having you in my life.
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CHAPTER 1
SLEEP DISORDERED BREATHING, COGNITIVE FUNCTIONING, AND ADHERENCE IN HEART FAILURE: LINKED THROUGH PATHOLOGY?

Introduction

Although cardiovascular disease (CVD) remains the leading cause of death in the United States, its age-adjusted mortality rates have decreased since the 1950s. This decrease is considered one of the most important public health success stories of the 20th century and is attributed primarily to improved outcomes following myocardial infarction. However, the prevalence of heart failure (HF), recognized as the final common pathway for all types of CVD, continues to increase with approximately 5 million Americans having the diagnosis of symptomatic HF. In recent years, highly effective, evidence-based guideline recommendations with demonstrated improvements in morbidity and mortality for the management of chronic HF have been developed. Adherence to the complex therapeutic regimen, however, has long been recognized as a challenge.

Adherence requires decisions to be made about prescribed therapies – specifically whether the advice given will be followed or not. Cognitive functioning is an important variable to be considered with any type of decision-
making. Cognitive impairment is of particular concern in patients with HF, who must remember to take multiple medications at various times throughout the day. For them, altered cognition is associated with reduced ability for self-care and increased morbidity and mortality, possibly directly related to decisions made and ultimately adherence to treatment plans (Hicks & Holmes, 2003; Zuccala et al., 2003).

Cognitive impairment is also a concern for those with sleep disordered breathing (SDB), who experience sleep deprivation, reduced attention spans, memory deficits, and excessive sleepiness. Interestingly, recent data have shown that 40-50% of patients with HF suffer from some form of SDB (Trupp et al., 2003, Javaheri et al., 1997; Young et al., 1997), primarily obstructive sleep apnea (OSA). The combination of HF and SDB can have particularly ominous consequences for cognitive functioning, decision-making, adherence, and, ultimately, outcomes. Specifically, this chapter proposes that the suboptimal adherence seen in patients with both HF and SDB results from a neurohormonal (NH) potentiation that occurs between the two conditions. Affecting adherence via common pathways that influence cognitive functioning and behavior are discussed.

**Neurohormonal Activation in Heart Failure**

HF is founded in aconceptual model of NH activation, which explains the circulatory and renal abnormalities, unrelenting disease progression, and high morbidity and mortality associated with this clinical syndrome. According to this model, an initial myocardial injury causes a fall in left ventricular (LV)
performance and cardiac output. This initial injury can result from a variety of causes, including myocardial infarction, hypertension, valvular disease, or it may just be idiopathic in nature. Regardless of the cause, the fall in cardiac output and blood pressure triggers adaptive, maladaptive, and counter-regulatory responses, specifically NH activation. As a result, LV performance may initially be adequate to meet metabolic needs with no symptoms of limited cardiac output. However, as NH activation continues over the course of months to years, the marked elevation in LV filling pressures, LV dilation, increased peripheral resistance, tachycardia, and increased myocardial workload eventually lead to symptoms of HF: paroxysmal nocturnal dyspnea or orthopnea, shortness of breath and chronic fatigue. HF is progressive and merciless in nature, unless the NH pathways are adequately blocked.

Cytokines are responsible for regulating immune responses, and the stress of HF can promote proinflammatory alterations that unfavorably affect left ventricular function (Levine et al., 1990), exert negative inotropic effects (Meldrum 1998), and worsen cardiac output (Torre-Amione et al., 1996). Tumor necrosis factor-alpha (TNF-α) is the proinflammatory cytokine that most closely corresponds to the severity of HF symptoms (Pasic et al., 2003), and, in fact, its over-expression is one of the maladaptive mechanisms responsible for disease progression (Rauchhaus et al., 2000). Proinflammatory cytokines may offer important prognostication as increased serum levels have been reported to predict 24-month mortality in HF. Additionally, cytokine activation promotes the development of endothelial dysfunction, general body wasting, skeletal muscle
apoptosis, and anorexia in advanced HF (Anker et al., 1997; Melrum, 1998; Pasic et al., 2003).

There is evidence of cognitive impairment in patients suffering from a variety of CVDs, including hypertension, post coronary artery bypass graft surgery (van Dijk et al., 2000) and among survivors of sudden cardiac death (Nunes et al, 2003). HF patients are likewise affected. In fact, the term “cardiogenic dementia” was first coined in 1977 to describe the cognitive dysfunction seen in HF (Lancet, 1977). In this population, cognitive impairment is reported to affect 23-50% of patients, even after adjusting for confounding variables (Schweitzer et al., 2007; Vogels et al., 2007; Riegel et al., 2002; Zuccala et al., 2001).

Generalized manifestations of cognitive impairment in HF include memory, attention, mental flexibility and global cognitive deficits (Clark & McDougall, 2006). An increasing body of evidence suggests low cardiac output, the hallmark of HF, as the culprit behind impairment in these cognitive domains (Clark & McDougall, 2006). Ineffective cardiac output results in hypoperfusion of the brain, altered delivery of oxygen and nutrients to cerebral tissues, and the progressive loss of neurocognitive processes (Vogels et al., 2007; Clark & McDougall, 2006). This premise has been supported in multiple studies reporting higher rates of cerebral infarcts and cortical atrophy (Almeida & Flicker, 2001) as well as reduced cerebral blood flow (Roman et al., 1997). Further evidence of a NH connection is found in the reversibility of cognitive impairment seen following cardiac transplantation (Roman et al., 1997; Bornstein et al., 1995; Deshields et
al., 1996). In one study, this change was found to be independent of significant improvements in depression and anxiety (Deshields et al., 1996).

**Neurohormonal Activation in Sleep Disordered Breathing**

Until the 1950's, sleep was thought of as a passive, dormant part of daily life. It is now known that the human brain remains very active during sleep. Moreover, sleep is essential to optimal health and performance. However, sleep deprivation is endemic in Western societies. While mild sleepiness is likely to produce only minor disruptions in social or occupational functioning, moderate sleepiness more noticeably affects these functions (Bliwise, 1991). Moderate sleepiness also is associated with inattention during activities that require focused attention, such as driving a car. Significantly, automobile accident rates in individuals with sleep deprivation have been reported to be 2-7 times the rate seen in the general population (Findley et al., 1988) and account for 20% of all serious auto accidents, making this problem equivalent to driving under the influence of alcohol (Connor et al., 2002). By interfering with attention and reaction times, sleep deprivation adversely affects cognitive performance and can produce consequences for judgment and decision-making (Durmer & Dinges, 2005). Severe sleepiness produces more neuropsychological deficits, including depression and cognitive dysfunction (Bliwise, 1991), as described below.

SDB is characterized by repetitive nightly recurrences of apnea and/or hypopnea, followed by a recovery phase with hyperpnea. This induces a cyclic pattern of intermittent hypoxia-reoxygenation, arousal, increased inspiratory
effort, sympathetic activation, and surges in blood pressure. These disturbances are strikingly similar in both central and obstructive sleep disorders and are associated with similar cardiovascular and immune system consequences.

During an apneic event, hypoxia stimulates chemoreceptors, mediating an increase in sympathetic nerve activity (SNA). This SNA produces vasoconstriction and surges in blood pressure. Following an arousal and recovery from apnea, or hypoxia-reoxygenation, a cyclic pattern of NH activation and blood pressure surges recur repeatedly throughout the sleep period, with carryover effects into the following day (Somers, 1995). This memory effect, or plasticity, in the neurocirculatory response is unique to the stimulus of intermittent hypoxia and establishes a strong link between SDB and hypertension (Peppard et al., 2000; Somers, 1995). In fact, even a single night of sleep deprivation has immediate effects on increasing blood pressure (Kato et al., 2000; Tochikubo et al., 1996).

Intermittent hypoxia also induces proinflammatory responses as well as increased levels of endothelin-1, free radicals, and suppression of nitric oxide, a potent vasodilator (Meier-Ewert et al., 2004; Kraicz et al., 2001). The repeated nightly cycles of hypoxia-reoxygenation-arousal influence cerebral oxygenation and blood flow (Valipour et al., 2002). This pattern may cause cerebral infarcts, resulting in the loss of brain tissue and permanent neuropsychological dysfunction (Valipour et al., 2002). Over time, this may manifest as cognitive impairment.

Sleep deprivation is becoming increasingly recognized as a contributor to
and/or predictor of a number of chronic conditions, including CVD, diabetes, gastroesophageal reflux disease, and psychiatric disorders. Because of accelerated NH activation, SDB may exacerbate pulmonary and cardiovascular conditions, leading to shorter life spans, especially if the SDB is untreated. ACE inhibitors have been shown to reduce the incidence of atrial fibrillation, an arrhythmia associated with cerebrovascular events, lending support for NH sequelae in brain pathology and cognitive functioning (Wagner et al., 2005). Additionally, research has shown that sleep disturbances impair quality of life and overall functional performance, including cognitive abilities (Skobel et al., 2005). In a compensatory response to sleep loss, dopamine levels are increased within the brain in order to promote wakefulness. However, these increased levels correlate with feelings of fatigue and impaired cognitive performance (Volkow et al., 2008). Even one night of sleep deprivation in healthy males has been shown to significantly reduce cognitive performance, producing more rigid thinking and reductions in the ability to appreciate new information (Tomasi et al., 2008; Harrison & Horne, 1999).

Cognitive Functioning

Cognition involves an individual’s ability to reason, understand, and learn. Cognitive impairment occurs when these processes are adversely affected. Although normal aging is not automatically associated with impaired cognitive abilities, estimates are that up to 17% of people age 65 and older experience some degree of mild to moderate cognitive impairment (Clark & McDougall, 2005).
However in HF, rates of cognitive dysfunction are much higher, with impairment reported in 23-50% of patients, even after adjusting for confounding variables (Schweitzer et al., 2007; Vogels et al., 2007; Riegel et al., 2002; Zuccala et al., 2001). Using the estimate of 5 million Americans with HF, this translates to 1.5 to 2.5 million individuals who may have altered cognitive functioning and impaired decision-making. A recent review of the literature examining the relationship between cognitive deterioration and HF determined the odds ratio to be 1.62 (95% confidence interval: 1.48–1.79, p<0.0001) among subjects with HF (Vogels et al., 2007).

Previous reports have shown that cognitive dysfunction in older adults may be partially associated with the presence of SDB and that an association exists between decrements in cognitive status and increased SDB severity over time (Zuccala et al., 2003). SDB is also linked to an increased incidence of CVD, such as stroke or transient ischemia attacks, both known to negatively impact cognitive abilities. While high-dose ACE inhibition has been suggested as treatment to block the NH effects seen with sleep deprivation (Wagner et al., 2005), using CPAP for at least 6 hours per night also results in the reversal of verbal memory impairments in patients with OSA (Zimmerman et al., 2006).

Cognitive performance is affected by other variables as well, including depression, social relationships, and quality of life. Pathological and behavioral factors influence depression among those with CVD, producing physiological sequelae of platelet aggregation, systemic and localized inflammatory responses, reduced heart rate variability, dysrhythmias, and NH activation (Joynt et al.,
Major depression is accompanied by a variety of immunomodulatory processes that affect innate responses of the immune system, with elevated TNF-α most consistently reported in HF and in SDB. In a longitudinal study, a causal link was established between depression and SDB, with odds for developing depression at least 1.6 times greater in individuals with SDB, even after adjusting for potential confounders such as age, body mass index, education, or history of CVD (Peppard et al., 2006). Additionally, even higher rates of depression are seen with increasing disease severity (Peppard et al., 2006).

Depression is known to be an independent risk factor for heart disease as well as an antecedent and risk factor for poor outcomes in HF (DiMatteo et al., 2000). Elevated TNF levels are seen in HF patients with increased depressive symptoms, suggestive of depression-specific proinflammatory cytokines that promote disease progression and mortality in patients with HF (DiMatteo et al., 2000). These increases are far greater than those reported in HF alone, lending support for a mechanistic role of inflammation in depression and HF. This association between depression and poor outcomes may be partly improved by adherence to prescribed therapies in both HF and SDB.

Adherence

Making decisions is an essential activity for human beings, yet understanding how decisions are made is quite complex. For the past several decades researchers have studied adherence to evaluate the clinical and physiologic outcomes seen following decisions made by patients about treatment
recommendations. However, inconsistencies in predictors of adherence have resulted. No evidence is found examining the relationship between OSA and adherence to CPAP in patients with CVD or HF.

The sleep deprivation that results from SDB has not only the previously discussed physiological consequences but also psychological ramifications likely to influence decision-making and adherence. Specifically, sleep-deprived individuals are more likely to develop depression, with symptoms of low energy, lack of motivation, poor judgment, and memory loss. As SDB and subsequent sleep deprivation worsen, so too do these symptoms. This cycle is further augmented by the chronic fatigue and sleepiness reported in individuals suffering from HF.

The impact of depression on adherence has been studied in a number of disease states, including diabetes, asthma, CVD, and HF. In a meta-analysis of 30 years of literature examining depression and adherence, depressed patients were 3 times more likely to be non-adherent to medical treatments (Jiang et al., 2002). The symptoms of HF and their negative impact on daily living and quality of life also contribute to the incidence of depression, with reported rates of 25-53% (Richardson, 2003). Those with HF who are depressed or who lack social support have been shown to have increased morbidity and hospital readmission rates, to be less adherent to their medical regimen, and to have an overall increase in cost of care (Richardson, 2003).

Social relations also impact adherence, as individuals without social support are less adherent to treatment regimens (Richardson, 2003). Lack of
social support, whether real or perceived, is associated with depression and thus has negative consequences for adherence. Additionally, social relations may mediate decisions made about adherence to prescribed therapies, either positively or negatively. While highly individualized, these inconsistencies may, in part, result from impaired judgment and altered decision-making stemming from persistent NH activation.

Besides the adverse neurocognitive effects, the synergism of SDB and HF may make the pharmacologic therapies directed solely at HF essentially futile, due to the nightly NH surges that follow the repeated hypoxia-reoxygenation-arousal cycles. As a result, HF disease progression, increased morbidity and mortality, reduced quality of life, and worsening symptoms would be anticipated. This synergism between HF and SDB may also offer one possible explanation as to why the outcomes reported in clinical trials of pharmaceutical or non-pharmaceutical HF interventions are not reproducible following market release and widespread use of the therapies.

**Clinical Implications**

Whether discussing HF or SDB treatment, excessive NH stimulation is the main target of therapy. In HF, ACE inhibitors (or angiotensin receptor blockers as acceptable alternatives) and beta-blockers constitute the cornerstones for NH blockade (Hunt et al., 2005). While treatment of central sleep apnea is not as well-defined, continuous positive airway pressure (CPAP) therapy is the gold standard for treating OSA. Acting as a pneumatic splint to maintain patency of the oropharyngeal airway, CPAP improves ventricular function, reduce
sleepiness, increase energy, and improve neurocognitive functioning (Castronovo et al., 2006). However, key to NH blockade is adherence to the therapy, whether discussing medications, CPAP, or both. Failure to take the medications or to use CPAP at least 4 hours per night as directed results in inadequate NH blockade, leading to disease progression, worsening symptoms, and poor outcomes.

Sleep deprivation resulting from SDB and OSA may compromise decisions made about adhering to prescribed therapies in patients with HF. Thus, treatment of SDB and OSA may improve the decisions made about adherence. Combined, enhanced adherence to medications, CPAP, or both would improve myocardial performance, sleep deprivation, and cognitive functioning, thereby potentiating the benefits for treatment of HF and SDB. (Figure 2.1).

Summary

The clinical impact of cognitive function and its influence on adherence is not always taken into consideration. Managing HF on a daily basis is multifaceted and complicated. Fundamental to adherence is the concrete execution of the tasks necessary to manage the treatment regimen. Patients must be actively involved in controlling the chronic condition and its symptoms, with complex medication regimens, dietary restrictions, and multiple healthcare appointments. The ability to manage HF becomes further complicated in the setting of sleep deprivation with altered attention spans, increased fatigue and memory deficits.

The NH perturbations seen in SDB may create a synergism with HF that
together alter cognitive functioning and physical performance. Through common pathophysiological pathways, altered decision-making capabilities may lead to suboptimal adherence to prescribed therapies. If interruption of the common pathways is possible through the clinical management of HF and SDB, cognitive impairment may be partially reversed and ultimately adherence may be enhanced. Key to this final step is the impact of improved adherence in both disease states.
References


Figure 1.1. Model depicting the synergism between heart failure and sleep disordered breathing on cognitive functioning and the impact of treatment in interrupting the cycle.
CHAPTER 2
PREDICTORS OF ADHERENCE TO CONTINUOUS POSITIVE AIRWAY THERAPY

Background

Prior to the 1950's, sleep was considered a passive, dormant part of daily life. It is now known, however, that the human brain remains very active during sleep. In fact, sleep affects daily functioning and physical and mental health in ways that are only now being fully appreciated. Poor sleep quality is also becoming increasingly recognized as a contributor to and/or predictor of a number of chronic conditions, including cardiovascular disease (CVD), gastroesophageal reflux disease, diabetes, and psychiatric disorders (Ancoli-Israel, 2006; Ayas et al. 2003; Ayas et al. 2003). A frequent cause of poor sleep quality is sleep disordered breathing (SDB), which affects approximately 5% of the general population and 30% of those with CVD (Peppard et al., 2000). SDB describes a family of disorders characterized by abnormalities in either the respiratory pattern or the quantity of respirations during sleep. Of particular concern is SDB manifested as obstructive sleep apnea (OSA).

OSA depicts the patient who “cannot breathe” due to hypotonia and collapse of the oropharyngeal airway during sleep. While the thoraco-abdominal
muscles continue the effort to breathe, airflow cannot pass through the upper airway obstruction. An apneic episode ensues and is terminated when the patient is briefly aroused, thus restoring upper airway muscle tone and relieving the obstruction. Effective breathing resumes. However, this is not a sentinel event. Rather, OSA generates a cyclic pattern of intermittent hypoxia – arousal – reoxygenation that results in increased inspiratory effort, sympathetic nervous system activation, increased myocardial workload, and surges in blood pressure. Consequently, OSA has been identified as an independent risk factor for hypertension (Peppard et al., 2000) and is a serious risk factor for other CVD, such as arrhythmias (Gami et al., 2007; Alonso-Fernandez et al., 2005; Gami et al., 2004), stroke (Yaggi et al., 2005; Dyken et al., 1996), coronary artery disease (Peker et al., 1999), sudden cardiac death (Gami et al., 2005) and heart failure (Bradley & Flores, 2003). Additionally, OSA is characterized by fragmented sleep, producing sleep deprivation, daytime sleepiness, reduced quality of life, mood changes such as depression and anxiety, and impaired cognitive functioning such as attention and memory deficits (Aloia et al., 2004; Engleman et al., 1997).

Continuous positive airway pressure (CPAP) therapy is the gold standard for treating OSA. By acting as a pneumatic splint to maintain a patent airway, CPAP is highly efficacious as it mitigates the acute physiologic responses seen with OSA. CPAP therapy has been shown to reduce blood pressure (Becker et al., 2003; Faccenda et al., 2001), arrhythmias (Gami et al., 2007; Kanagala et al., 2003), and daytime sleepiness (Weaver et al., 2007) and to improve left
ventricular function (Kaneko et al., 2003), as well as quality of life (Sin et al., 2002) and cognitive functioning (Castronovo et al. 2006; Engleman et al., 1997).

While treatment with CPAP should be valued as highly as medications or other treatments for chronic conditions, adherence to CPAP is notoriously suboptimal and associated with highly variable rates of usage (McArdle et al., 1999; Weaver et al., 1997). Less than 50% of patients prescribed CPAP even try it once, and many simply quit after one night of use. Additionally, less than 25-50% of those prescribed CPAP continue to use it after one year (Budhiraja et al, 2007; Loube et al., 1999).

Given the evidence supporting the efficacy of CPAP, predicting who will or will not use CPAP remains a clinically significant question, as early interventions may enhance CPAP acceptance and use. While a number of variables, such as age, gender, and extent of daytime sleepiness have been shown to predict adherence to CPAP in some studies (Wild et al., 2001; Engleman et al., 2001), in others they have not been predictive (Johnson et al., 2004; Reeves-Hoche et al., 1994). These incongruencies are discussed below.

**Adherence to CPAP Therapy**

Using objective measures, CPAP usage rates are established early (within 3-7 days) and are not easily altered after the initial exposure (Budhiraja et al, 2007; Aloia et al., 2005; McArdle et al., 1999; Weaver et al., 1997; Kribbs et al., 1993). Non-adherence to CPAP may result from real or perceived difficulties related to its use, with common complaints of nasal dryness, dry eyes, and bothersome noise levels (Engleman & Wild, 2003). Although a number of device-
related strategies have targeted these side effects, such as bi-level pressure delivery, nasal “pillows” or humidification, poor adherence remains an ongoing issue. Yet, since two-thirds of CPAP users report side effects, side effects alone do not seem to be the critical deterrent to use (Weaver & Grunstein, 2008).

In sleep adherence research, definitions for adherence to CPAP vary significantly. There is currently no standard definition for optimal, or even adequate, adherence for the treatment of apnea/hypopnea events. While evidence does exist that any CPAP use is better than no use, there appears to be a linear relationship between CPAP use and outcomes. In fact, it has been suggested that optimal use should be outcome specific, rather than just simply looking at hours of device use (Weaver & Grunstein, 2008). However, average CPAP use of 4 or more hours per night for 70% of nights continues to be the most commonly accepted definition of adherence (Dinges & Weaver, 2007; Kribbs et al., 1986). Still, even this definition is problematic, as it essentially endorses CPAP use for only half of the total recommended sleep time for adults.

Early studies with self-reported adherence identified high rates of adherence, as patients over-estimated their use of CPAP (McArdle et al., 1999). One study even found that patients with poorer compliance consistently over-reported their total time of CPAP use (Rauscher et al., 1993). Once CPAP devices with built-in timers became available, objective data revealed that subjective data was very unreliable and that CPAP use was over-estimated (Engleman et al., 1994), irregular, and not at prescribed levels (Hoy et al., 1999; Kribbs et al., 1986; Weaver et al., 1997). Now essentially all CPAP devices...
provide objective data on CPAP usage, using SmartCard technology that collects and stores information that can be easily retrieved and reviewed.

Reported long-term estimates of adherence have ranged from less than 50% to 70-80% (Grote et al., 2000; McArdle et al., 1999; Pepin et al., 1999; Edinger et al., 1994; Kribbs et al., 1993b). However, the wide variation may in part be due to how adherence is defined. For example, McArdle and colleagues reported CPAP adherence of 85% at 6 months using a definition of an average CPAP device use for more than 2 hours per night, while Pepin and colleagues reported 79% and Kribbs et al reported 46% at 3 months, when adherence was classified as CPAP use for more than 4 hours per night for more than 70% of nights.

Predictors of Adherence

In order to maximize the delivery of CPAP therapy and to improve clinical outcomes, it is important to understand the variables associated with adherence. To this end, much research has been conducted, but the findings have been inconsistent as some studies report multiple predictors, while others find none.

Physical Characteristics

Physical characteristics, such as weight, body/mass index (BMI), age, neck circumference and gender, have been found to have a weak relationship with CPAP adherence in some studies, (Wild et al., 2001; Engleman et al., 2001), while others have reported no relationship (Johnson et al., 2004; Edinger et al., 1994). Limited data are available on the role that race/ethnicity plays in adherence to CPAP therapy (Scharf et al., 2004). In one study, after adjusting for
age, apnea-hypopnea index (AHI), sleepiness, and depression, African Americans were found to use CPAP 1.74 hrs per night less than Caucasians at 30 days (p=.0304) (Sawyer et al., 2008). In this same study, no statistically significant race/ethnicity difference in adherence was found at one week.

Psychosocial Variables

Marital status, education and socioeconomic status have not consistently been associated with CPAP adherence. While individuals who live alone have been found to be less likely to use CPAP (Hoy et al., 1999), almost half of patients with OSA report that they would discontinue CPAP if it negatively affected the sleep of their bed partner (Weaver et al., 2003). A few studies have found social support to have a positive impact on adherence (Joo & Herdegen, 2007; Lewis et al., 2004).

In chronic diseases, such as CVD or OSA, self-efficacy (SE), or an individual’s belief in his or her capacity to engage in the behavior(s) that may lead to desired outcomes, impacts an individual’s perceived ability to perform desired self-care behaviors. Because SE is potentially modifiable, interventions have focused on enhancing SE with the goal of improving self-care abilities that are essential for maintaining physical and mental well-being, such as adherence to prescribed therapies. Unlike costly medications or surgery, there are few risks associated with enhancing a patient’s confidence, resourcefulness, and psychosocial SE. While SE has been studied in a variety of conditions, including CVD (Dracup et al., 2003; Clark et al., 1999) and pulmonary disease (Clark et al., 1999), recent research in SE and CPAP adherence is encouraging, as greater
SE has been found to be associated with improved adherence in first time users of the therapy (Olsen et al., 2008; Stepnowsky et al., 2007; Aloia et al., 2005; Wild et al., 2004; Stepnowsky et al., 2002).

Both depression and OSA have independently been shown to be associated with the development of CVD (Joyn et al., 2003; Millman et al., 1989). Despite a number of methodological considerations, such as sample size, gender and age distributions, or definitions of disease severity, the evidence supports a correlation between OSA and depression (Schroder & O’Hara, 2005). Although depression is known to negatively impact adherence in a number of conditions, depression’s influence on adherence to CPAP is less consistent (Wells et al., 2007; Lewis et al., 2004; Murray et al., 2002; Edinger et al., 1997). For example, one prospective study failed to find any association between depression at baseline and adherence at one month (Lewis et al., 2004), while another found a positive correlation at 6 months (Edinger et al., 1994). However, it is important to note that a large number of studies investigating adherence in CPAP excluded individuals with clinical depression or included only those with normal depression scores at baseline.

A sense of optimism, or positive expectations for the future, has been shown to offer health protective effects. While dispositional optimism as a relatively stable personality trait has been studied in a number of conditions, including CVD (Gramling et al., 2008; Giltay et al., 2007; Kubzansky et al., 2001; Sears et al., 2005; Schier et al., 1999), HIV (Ironson et al., 2005), and cancer (Schofield et al., 2004; Allison et al., 2003), few studies have explored
dispositional optimism as a predictor of adherence. In those that have, the results have been mixed (Ironson et al., 2005; Schofield et al., 2004; Glazer et al., 2002). No literature was found examining dispositional optimism and adherence to CPAP.

Disease Severity

Sleep study parameters. No difference between CPAP adherent and non-adherent individuals have been found in the majority of studies evaluating a variety of disease severity parameters, as measured during polysomnography (PSG) or sleep study at baseline, including apnea hypopnea index (AHI), prescribed CPAP pressure, total sleep time, or desaturations (Wells et al., 2007; Zozula & Rosen, 2001; Pepin et al., 1999; Weaver et al., 1997). Some studies have reported greater adherence in those with higher AHIs (McArdle et al., 1999; Krieger & Kurtz, 1988). Conversely, one study with a significant correlation that explained very little variance in CPAP use concluded baseline AHI was not important (Douglas & Engleman, 1998).

Sleepiness. A number of psychomotor and performance tests have been used to objectively assess daytime sleepiness, but they are unwieldy and often inconsistent, making their clinical applicability limited (Johns, 2000). The Epworth Sleepiness Scale (ESS) was developed to measure subjective sleepiness during activities of normal daily living and has been used extensively in sleep research (Johns, 1993). Greater sleepiness at baseline has been most consistently associated with CPAP use, through symptom reduction. An association between improvement in baseline ESS scores and adherence to CPAP has been found in
some studies (Wells et al., 2007; Lewis et al., 2004; McArdle et al., 1999) but not seen in others (Budhiraja et al., 2007; Lacassagne 2000). However, specifically who will experience reduced sleepiness and derive benefit from CPAP at baseline is unknown.

Conclusion

Much research has been done examining predictors for adherence to CPAP. Some has been conducted prospectively, while others have been largely retrospective in nature. To date, no reliable variables have been identified that can consistently predict who will or will not use CPAP prior to the initiation of treatment. Inconsistencies in what variable to measure, how to measure that variable, and how adherence is defined further add to the confusion.

Therefore, the first aim to be addressed by this study was to describe the physical, psychosocial and disease severity characteristics of the sample. The second research question assessed the association between these variables and CPAP adherence. Specifically, what relationship, if any, exists between the physical, psychosocial and disease severity variables and 30-day adherence? Finally the third, and major, research question evaluated significant variables and adherence. In particular, what physical, psychosocial or disease severity variables, if any, are the best predictors of adherence to CPAP at 30 days?

Methods

Research Design

The study used a prospective design to evaluate the predictors of adherence to CPAP. The data of interest were collected prior to treatment with
CPAP. The dependent variable of interest was 30-day adherence to CPAP, with dispositional optimism, SE, depression, and sleepiness as key independent variables.

Sample

The convenience sample enrolled patients with a history of CVD who were newly diagnosed with OSA. These patients were part of a study testing an educational intervention for adherence that included weekly phone calls over the course of the first month of home CPAP therapy. Inclusion criteria were identified that would be most reflective of the population with high prevalence for sleep disorders and at increased risk for poor outcomes from non-adherence to CPAP therapy. Specifically, these included: adult patients (21-80 years old) with a history of CVD, newly diagnosed with OSA, no previous experience with CPAP, and prescribed treatment with CPAP therapy. While patients with an apnea/hypopnea index (AHI) greater than or equal to 15/hour are considered to be eligible for CPAP treatment, this study enrolled any patient that was prescribed CPAP therapy by the sleep specialist, regardless of the baseline AHI. Patients who were already using CPAP devices, had used CPAP before, had previously been intolerant of CPAP, were diagnosed with primarily central sleep apnea, or were participating in another clinical trial were excluded from participation.

To reduce potential confounding, it was essential that usual care about CPAP therapy not be altered by this study. Therefore, the sleep specialist, sleep lab staff, and/or CPAP equipment providers continued to present standard
information about CPAP therapy, including potential risks and benefits, in their customary terms and phrases. When questions arose about CPAP during the weekly phone calls for this study, patients were referred to their physician.

Procedure

The study was reviewed by and in compliance with The Ohio State University Institutional Review Board. Participants were recruited from patients undergoing a scheduled second PSG study for the initiation and titration of CPAP therapy. OSA was diagnosed in all participants following a first in-laboratory overnight PSG study conducted at The Ohio State University Hospital East Sleep Laboratory, using standard scoring techniques. All sleep studies were scored and interpreted by an American Board of Sleep Medicine certified sleep specialist. Participants were enrolled between October 2007 and April 2008.

Sleep lab technicians, who had been educated on the research trial, reviewed the medical records of patients scheduled for a second PSG for CPAP initiation and titration. Patients identified with a history of CVD were approached about participating in this study by the sleep lab technicians. If the patients expressed interest, a member of the research team provided further information to the patient about the research protocol and answered all questions. Patients expressing an interest in participating were then asked to read and sign the informed consent and HIPAA authorization documents.

Upon obtaining consent, a semi-structured interview was conducted and surveys were completed to yield self-reported baseline data, including demographic characteristics and physical traits. Information on disease severity,
such as AHI and lowest oxygen saturation, were retrieved from medical records of the diagnostic PSG. In an attempt to further understand treatment decisions made by patients about CPAP, measurement of psychosocial variables of interest were also conducted including: sleepiness, inherent personality (specifically, dispositional optimism), depression, and attitudes toward managing the CPAP (SE).

Following collection of these baseline data, as part of the broader study, participants were randomized to receive one of two educational interventions targeting adherence. The intervention consisted of a brief educational video about CPAP that was either framed positively, focusing on the benefits associated with CPAP use, or negatively, emphasizing the negative consequences that may occur if CPAP was not worn as directed. Each subject viewed the video presentation on a one-by-one basis. A magnet reinforcing the assigned educational message was given to all subjects, who were asked to place it in a prominent location (i.e., on the refrigerator), so that they could refer to it several times a day. Additionally, once home CPAP therapy was initiated, subjects received a weekly phone call for 4 weeks that reinforced the assigned educational message using an IRB-approved standard script. (The findings of this larger study are reported in Chapter 4).

Usual procedures for the delivery of CPAP therapy to participants’ homes were maintained. Following approximately one month of home CPAP therapy, participants returned to their sleep specialist for routine care and follow-up. At
this visit, adherence data on one-month home CPAP usage was retrieved from the device.

Measures

Adherence. Objective data on adherence was collected from the CPAP device following the first 30 days of home therapy. Data were analyzed to determine the number of nights that CPAP was used for at least 4 hours. Since the majority of evidence defines CPAP adherence as an average use of CPAP for 4 hours or more per night for at least 5 nights per week to improve clinical outcomes, a usage index was calculated as a percentage for each subject (number of days that CPAP usage was 4 or more hours divided by the total number of days studied x 100) (Budhiraja et al, 2007). Values approaching 100% indicated greater adherence. Additionally, since some studies reported adherence dichotomously, the usage index was also used to categorize participants as being adherent or not. Those with a usage index of 70% or greater were classified as “yes,” whereas those with usage index less than 70% were classified as “no”.

Epworth Sleepiness Scale. The Epworth Sleepiness Scale (ESS) is a self-report instrument consisting of 8 questions that ask about the likelihood of falling asleep in a variety of situations, some known to be soporific (lying down, watching television), others less so (i.e. sitting in traffic, conversation) (Johns, 1991). The ESS requires subjects to use a 0-3 scale (0 = would never doze off during the activity, 3 = very high chance of dozing off during the activity) to rate the chance of dozing as part of his “usual way of life in recent times” (Johns,
Potential scores range from 0 to 24. A score less than 10 suggests excessive sleepiness is not a problem, while 10 or more has a 93.5% sensitivity and 100% specificity in distinguishing pathologic from normal daytime sleepiness (Johns, 2000). Internal consistency in 2 different groups of 150 patients with various sleep disorders had a Cronbach’s alpha of 0.88, while the Cronbach’s alpha for 104 medical students was 0.73 (Johns, 1992).

Self-Efficacy. A subscale on self-efficacy (SE), from a questionnaire developed specifically to evaluate social cognitive variables after initial exposure to CPAP in individuals with OSA, was administered (Stepnowsky et al., 2002). Subjects were asked the following questions: 1. I am confident that I can use CPAP regularly, 2. I have the ability to use CPAP regularly, 3. I am confident I will use CPAP regularly even if I do not feel like it, 4. I am confident I will use CPAP regularly even if I experience uncomfortable side effects, 5. I can operate the CPAP machine to make it more comfortable for me. A 5-point scale was employed (0 = disagree a lot; 4 = agree a lot). Ranges are from 0 to 20, and higher scores are indicative of higher levels of personal confidence in using CPAP therapy. The SE questions have been validated and shown to be positively associated with CPAP adherence at 1 month (Stepnowsky et al., 2002).

Depression. Symptoms of depression were measured with the Center for Epidemiological Studies Depression Scale (CES-D). The CES-D (Radloff, 1977) is a 20-item self-report scale that is one of the most commonly used depression screening tools in community-dwelling populations (Gotlib & Cane, 1989). In the
standard protocol for this screening scale, statements such as “I felt that everything I did was an effort” and “people were unfriendly” are read by the participants. They are asked to consider how often they felt this way during the previous week and to respond to the statements on a 4-point scale from 0 (rarely or none of the time) to 3 (most or all of the time). Four questions are reverse scored. The possible score range is 0 to 60 points with higher scores indicative of more symptoms of depression. A cutoff point of 16 was used in this study to identify severe depressive symptomology (Radloff, 1977).

Dispositional Optimism. The Life Orientation Tool Revised (LOT-R) is an eight item self-report instrument (with 3 filler items) that uses 5-point Likert scales, ranging from “strongly disagree” (0) to “strongly agree” (4). Dispositional optimism is defined as the extent to which one anticipates positive outcomes for the future. Higher scores are associated with optimism and positive expectations for the future, and the range is 0-32. It has a reported test-retest reliability of 0.78 (Scheier & Carver, 1992; Scheier & Carver, 1985).

Statistical Analysis

Research question 1 (baseline characteristics): Using SPSS version 16 (SPSS Inc, Chicago, IL), descriptive statistics, including percentages, means, and standard deviations were calculated to provide characteristics for all participants (n=70) and for those with (n=55) and without (n=15) adherence data (Table 2.1 and Table 2.2). In addition, to verify there were no between group differences based on assignment (positive or negative message framing),
separate one way analyses of variance (ANOVA) or chi-square analyses were conducted.

Research question 2 (relationship between variables and adherence): To evaluate over-all CPAP adherence, data were analyzed both as a continuous variable (actual percentage of CPAP use for 4 or more hours over the 30 day period; the usage index) and as a dichotomized variable (yes or no, based on the usage index). To evaluate the association between baseline variables and adherence to CPAP at 30 days, correlational analyses (Pearson’s or chi-square) were calculated. In addition, ANOVA was employed to determine differences in total adherence to CPAP based on group assignment. Because previous literature suggested that early usage was predictive of longer term usage (Budhiraja et al, 2007; McArdle et al., 1999; Weaver et al., 1997), a regression analysis was performed to explore the impact of first night usage, as an independent variable, on 30 day adherence (dichotomized) using chi-square analysis.

Research question 3: Predictors of adherence. To determine which variables predicted adherence to CPAP, a linear regression was performed, with adherence measured as a continuous variable.

Currently there are no studies available using these same variables from which to base sample size nor any objective method for determining adherence in advance. Therefore, the sample size estimate was calculated as 30 per group assignment (10 for each of the 3 major variables of interest: educational message framing, self-efficacy, and dispositional optimism) and power of 0.8
Ten additional participants (17%) were added in case of attrition. Sample size was set at 70 participants. For clinical significance, the $P$ value was set a priori at 0.05, and all reported $P$ values are two-tailed.

Post hoc analysis. During the course of the study, a large variation was evident in the time interval between the second PSG for CPAP titration and the participant’s receipt of the CPAP device at home. The effect of this time interval, measured in the number of days between the second PSG and receipt of the home CPAP device, on 30 day adherence was explored using either Pearson correlations or chi-square analysis, as appropriate.

Results

Eligible Subjects

Seventy-six patients were approached about participation in this study, and 70 agreed to participate. Of the 6 eligible patients who did not agree to participate and who are not included in further analyses, it is important to note that these individuals were slightly older (mean age 58.17 ± 9.2), had slightly lower AHIs indicative of moderate OSA (mean AHI 34.27 ± 33.83), and experienced less nocturnal hypoxia (mean oxygen saturation 81.33 ± 2.94), as compared to the study cohort (Table 2.1 and 2.2). However, further interpretation of this data is beyond the scope of this study, as larger numbers are necessary for meaningful analysis.

Random assignment of the 70 participants providing informed consent resulted in 34 receiving the positive framed educational message and 36 receiving the negative framed educational message. Of the 70 agreeing to
participate, final data on adherence were not available for 15 subjects. Of these, 3 did not tolerate CPAP titration, left during the second PSG, and did not return for any follow-up care thereafter (1 randomized to the positive and 2 randomized to the negative message framing groups). Eight additional participants received their home CPAP device but were lost to follow-up, as they did not return for subsequent care at the sleep clinic, despite multiple attempts to reach them via telephone and mail. Of these 8, 6 had been randomized to receive the positive framed message, and 2 to receive the negative framed message. The lost to follow-up rate was 18% for the positive message group and less than 1% for the negative message group; this difference was not statistically significant. In addition, adherence data were not available on 2 participants (1 in each group) who received an “older” CPAP device that did not store information on machine use. Data for 2 participants could not be retrieved due to a computer malfunction (randomized to negative message group).

Sample With Adherence Data

Characteristics of the 55 participants with adherence data are presented.

Description of the sample. Baseline demographic and physical characteristics of are shown in Table 2.1, and baseline psychosocial and disease severity variables are shown in Table 2.2. There were no significant between group differences in any baseline variable based on group assignment nor between those with and without adherence data.

Over the course of 30 days, the mean percent CPAP usage for the study cohort was 52% (median 53%; range 0 to 100%). When defining adherence as a
usage index of 70% or greater, 53% (n=29) of the sample were adherent at 30 days. When evaluating race/ethnicity and adherence, 48% of Caucasians (19 of 40), 25% of African Americans (3 of 12), 0% of Asian (0 of 1), and 0% of Hispanics (0 of 2) were adherent (usage index ≥ 70%). The adherence rates were not significantly different between the race/ethnicity groups, most likely due to small sample size.

Relationship between variables and adherence. Group assignment at baseline (Spearman’s rho=0.327, p=0.015, n=55) and first night usage (Spearman’s rho=0.624, p<0.001, n=55) were the only variables demonstrating significant correlations with adherence at 30 days (Table 2.3). When defined as a continuous variable, adherence was significantly greater in the group assigned to receive negative message framing. In this group (n = 29), the average CPAP usage at 30 days was 63%, compared to 41% in the group randomized to positive message framing (n = 26) (t=-2.37, df=53, p=0.021). Similarly, when categorizing participants into those with or without a usage index of 70% or greater, there were no differences in baseline variables (p=.708), except for group assignment. For those receiving negative message framing, 55% (16 of 29) had a usage index of 70% or greater at 30 days. In contrast, 23% (6 of 26) of those who received positive message framing were adherent. This between-group difference was significant (Pearson’s chi-square=5.884, df=1, p=0.015). (Figure 2.1). Using the 30 day usage index of 70% or greater, greater adherence was found in those who used their CPAP for 4 or more hours on the first night, compared to those using CPAP less than 4 hours. Of the 55 with
complete data, 29 were adherent to CPAP on the first night (16 in negative frame, 13 in positive frame group), and of these, 20 (69%) continued to be adherent at 30 days. In contrast, 26 participants used CPAP for less than 4 hours the first night (13 in each message frame group), and only 2 (8%) were adherent at 30 days. This between-group difference was significant (Pearson's chi-square=33.874, df=1, p<0.001). Interestingly, group assignment was not related to first night usage, suggesting that the effects of group assignment and first night usage on adherence are independent.

In order to understand what impacts first night usage, separate ANOVAs were used to compare baseline variables among first night users and non-users. The only significant variable that differed between users and non-users was SE, with higher SE scores reported in those who used CPAP the first night (15.07 ± 3.47), compared to non-users (12.88 ± 2.80) (F=6.218, df=1,51, p=0.016).

Predictors of adherence. A linear regression analysis was performed using group assignment, first night usage, and dispositional optimism, regressed on adherence as a continuous variable. This model accounted for 58% of the variance in CPAP adherence (Table 2.4). By far, the most important variable was first night usage, accounting for 44% of the variance in adherence. Adding group assignment further increased the variance explained by 9%, to 53%. Finally, the addition of dispositional optimism further increased the variance explained by 5%, to total 58%. SE did not contribute to the model. All other variables, including depression, when added to the regression model, had no effect.
Post Hoc Analysis: The average time interval between when subjects had the second PSG for CPAP titration and when they actually began to use CPAP at home was 27.8 days (SD 17.2 days; range, 1-87 days). However, the time interval failed to predict CPAP adherence at 30 days.

Discussion

This study supports the findings of others that specific physical, social, or disease severity variables, collected at baseline, are not predictive of adherence to CPAP therapy. Although the mean AHI indicated moderate OSA (mean AHI 39.72 events/hour) and subjects experienced significant nocturnal hyoxemia (mean oxygen saturation 77.86%), neither variable was predictive of CPAP use at 30 days.

Also as found in other studies, early experience with CPAP was predictive of later use in this study. Although others have found CPAP rates to be established within the first 3-7 days of therapy, not easily altered after that initial exposure, and predictive of long-term use (Budhiraja et al., 2007; McArdle et al., 1999; Weaver et al., 1997), this study further expands the early experience to include the first night as an important issue for adherence. This may be related to educational instructions given about home use of the equipment, SE, attitude toward the therapy, or a number of other variables.

While reduced sleepiness can be a positive outcome of using CPAP, the baseline level of sleepiness at the start of treatment with CPAP may likewise influence adherence. Individuals without excessive daytime sleepiness are less likely to perceive any improvement in sleepiness with CPAP. In this study, no
A correlation was found between baseline scores of the ESS and adherence at 30 days. However, the mean ESS score for those with adherence data was $9.91 \pm 4.87$, indicating participants were not experiencing excessive daytime sleepiness. When sleepiness was examined by group assignment, the negative message framing group had a mean ESS of $10.41 \pm 4.98$, compared to the mean ESS of $9.35 \pm 4.73$ in the positive message framing group, although this between-group difference was not significant ($p = .420$). As suggested by others, a fall in ESS scores, rather than the absolute ESS at baseline, may be a better predictor of adherence to CPAP (Sin et al., 2002).

Anything that can positively impact thinking and social behavior has great implications for society, especially in the domain of healthcare where non-adherence is associated with high morbidity, mortality, and economic burden. The importance of regular adherence to CPAP was highlighted in a longitudinal study that demonstrated a 5-year survival benefit for patients who used the therapy for 6 or more hours per night, as compared to nonusers (Campos-Rodriguez et al., 2005). Suboptimal adherence was seen in the current study. However, it should be acknowledged that non-adherence is not unique to CPAP but rather is a common feature in a number of chronic conditions. What is unique from the current study is that objective information about first night use offers an important opportunity for early intervention and for reinforcement of the consequences of untreated OSA before patterns of use have been firmly established. This study appears to be the first to report first night use of CPAP as a predictor of adherence at 30 days.
Even though a number of behavioral interventions targeting enhanced adherence to CPAP therapy have had mixed results, a recent review suggested that behavioral interventions, such as education initiatives, do show some promise (Haniffa et al., 2004). In addition, the National Center for Sleep Disorders Research (2003) identified the understanding of factors essential for adherence to CPAP as a critical research issue. Behavioral change processes are hypothesized to be a function of the perceived value of the outcome, the perceived risk of the outcome, or some combination of both (Wilson et al., 1988). The perception of risk is likely to be influenced by psychological traits, such as depression or dispositional optimism, and exert effects on decision-making. This may be especially pertinent with CPAP therapy, which requires significant behavioral change through nightly use and lifelong commitment to the cumbersome, obtrusive device.

According to Prospect Theory (Kahneman & Tversky, 1979), people encode information received in terms of potential losses or gains from their status quo and subsequently use this perception to make decisions. In situations considered risky, perceived losses from inaction should motivate behavioral change more than perceived gains resulting from action (Kahneman & Tversky, 1979). This study supports that premise, as those receiving negatively framed messages focusing on the potential losses that may occur if CPAP is not used, were more effective in persuading individuals to use it. Some have proposed that patients with multiple health problems and overlapping treatment regimens may be overwhelmed by negative health messages, leading to decreased adherence
to CPAP (Olsen et al., 2008). However, in this study, the opposite was found, as participants had pre-existing CVD, but only those who received negatively framed messages were more adherent to CPAP at 30 days. Perhaps this difference is related to how patients with a chronic disease evaluate the risk associated with a new diagnosis and treatment, in relation to their current health status.

This study found no significant correlation between baseline depression, SE, and dispositional optimism and adherence at 30 days. Others have reported that the baseline assessment of behavior change principles, such as SE, were not predictive of long-term adherence and have suggested that patients benefit in their ability to discuss behavior change only after they have experienced CPAP (Aloia et al., 2005; Stepnowsky et al., 2002). However in this current study, unlike SE, when dispositional optimism was entered into the stepwise regression analysis, it was significant suggesting that a relationship exists between these variables. (Table 2.4).

There is substantial evidence supporting the role of emotion and affect in decision-making. In particular, dispositional optimism appears to be a mediator in risk-taking behavior, as optimists subjectively have greater value for loss, thus making potential negative outcomes seem worse and resulting in behavioral adaptation to maintain the positive state. In fact, focus group work has shown that optimists appear more likely to emphasize the potential benefits of treatments, as compared to pessimists who focus on potential risks (Leydon et al., 2000). This is consistent with suggestions by Carver and Scheier (1998) that
optimists are more likely to persist toward goal attainment, even in the face of adversity. As reported by others, dispositional optimism may keep people more behaviorally engaged and appears to offer resistance to depression (Ironson et al., 2005). Even though no significant correlations were seen between baseline optimism and adherence (Pearson's correlation=.102, p=.462, n=54), this may, at least partially, explain why those receiving negatively framed messages about CPAP were more adherent to the therapy at 30 days. By emphasizing the consequences of untreated OSA and to mitigate further health loss or risk, dispositional optimism may mediate behavioral adaptation and adherence to CPAP in this group.

Message framing has been previously studied in both health promotion and disease detection activities (Rivers et al., 2005; Apanovitch et al., 2003; McCall et al., 2004; Meyerowitz & Chaiken, 1987). Results have shown that, in health promotion activities, such as physical exercise or using sunscreen, positively framed educational messages that emphasize the good outcomes associated with a behavior, are more effective. Conversely, in disease detection activities, such as breast self-examination or HIV testing, educational messages that are negatively framed and focus on the negative consequences from inaction are more effective. Missing in the literature is the impact of message framing on patients with chronic disease and prescribed therapies.

This study appears to be the first to examine the impact of message framing on adherence to a prescribed therapy, specifically CPAP. It is postulated from these findings that individuals with a chronic disease may be more adherent
to CPAP when given education on the negative consequences that may result from untreated OSA. Enhancing behavioral variables through early education on the negative consequences of untreated OSA may be an important opportunity to improve adherence. In doing so, motivation to use CPAP may be enhanced.

Limitations

There are several limitations associated with this study that must be acknowledged. First, the results are from a study on adherence to CPAP in which subjects were randomized to receive an educational message. As such, the intervention had some impact on CPAP use, although the overall adherence results are still suboptimal. Additionally, the information provided to patients from the sleep physician, sleep lab staff and respiratory company was not standardized and, through observation, was highly variable in respect to OSA, CPAP therapy, adherence data collected by the CPAP device, and the consequences of untreated OSA. This educational issue may be especially relevant to CPAP therapy, given that it is obtrusive by nature and may present more barriers to adherence than other therapies, such as medications. As a result, individuals who receive inconsistent and/or inaccurate information about CPAP therapy may be more likely to perceive barriers, less likely to troubleshoot and more likely to abandon the therapy. In addition, adherence data on 15 of the 70 (21%) enrolled and randomized subjects were not available, with a potential of diminished power.
Summary

Adherence to CPAP is a multi-dimensional concept that includes technology, education, initial experience, behavior and personality. It is critically important to understand factors that influence patients’ decisions about following medical advice and treatment recommendations in order to optimize adherence. This is especially pertinent for the early adoption of and behaviors related to CPAP use and its efficacy. How information is presented provides a vital opportunity to persuade and motivate with great implications for education, adherence, and outcomes for patients and healthcare providers alike. In order to enhance adherence to CPAP therapy, changes in behavior are required in the course of treatment, especially during the initial home experience. Providing consistent and accurate information about OSA and the negative consequences that may result from not using CPAP appears to be an opportunity for enhancing adherence. In patients with CVD, educational messages that were negatively framed significantly impacted CPAP use and are worthy of further investigation. Since early CPAP use is predictive of sustained use, it is important to assess adherence early in the treatment phase and to address factors that may negatively impact adherence.
References


Weaver, T.E., Maislin, G., Dingess, D.F., et al. (2007). Relationship between hours of CPAP use and achieving normal levels of sleepiness and daily functioning. Sleep Medicine Reviews, 30, 711-719.


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<td>n (%)</td>
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Table 2.1. Selected demographics of total sample at baseline and of subjects with and without complete adherence data.
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<td></td>
<td></td>
<td></td>
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<td>Lowest Oxygen Saturation, %</td>
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<td></td>
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<tr>
<td>Average events/hr</td>
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<td></td>
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<tr>
<td>Mean ± SD</td>
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Table 2.2. Selected baseline psychosocial and disease severity characteristics

ESS, Epworth Sleepiness Score; LOTR, Life Outcomes Tool Revised; CESD, Centers for Epidemiologic Studies – Depression; SE, Self Efficacy; AHI, Apnea Hypopnea Index.
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<td>Age</td>
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<td>.059</td>
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<tr>
<td>Gender</td>
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<td>.216</td>
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<td>Education</td>
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<td>Lives alone</td>
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<td>BMI</td>
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<td>AHI</td>
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<td>.124</td>
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<tr>
<td>1st Night Use</td>
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<td>.624**</td>
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Table 2.3. Correlation coefficients between selected baseline variables and adherence.

*p< 0.05 (2-tailed). **p< 0.01 (2-tailed).

ESS, Epworth Sleepiness Score; LOTR, Life Outcomes Tool Revised; CESD, Centers for Epidemiologic Studies – Depression; SE, Self Efficacy; AHI, Apnea Hypopnea Index.
<table>
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<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>Beta</th>
<th>$t$</th>
<th>$p$</th>
<th>Cumulative $R^2$</th>
<th>$R^2 \Delta$</th>
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<tr>
<td>1st night use</td>
<td>47.6</td>
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<td>6.393</td>
<td>.000</td>
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<td>44%</td>
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<tr>
<td>Group assignment</td>
<td>20.9</td>
<td>.294</td>
<td>3.029</td>
<td>.004</td>
<td>53%</td>
<td>9%</td>
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<tr>
<td>Optimism</td>
<td>2.91</td>
<td>.216</td>
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<td>.026</td>
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<td>5%</td>
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<tr>
<td>Self-efficacy</td>
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<td>-.025</td>
<td>-.224</td>
<td>.824</td>
<td>58%</td>
<td>0%</td>
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Note: $R^2 = .577$, $F(3,49) = 22.243$; $p = .000$

Table 2.4. Linear regression using adherence as the dependent variable.
Figure 2.1. 30-day adherence (as a usage index of 70% or greater) and group assignment (p=.015)
CHAPTER 3
THE IMPACT OF MESSAGE FRAMING ON ADHERENCE TO CONTINUOUS
POSITIVE AIRWAY PRESSURE THERAPY

Background
Sleep disordered breathing (SDB) describes a family of disorders depicted by abnormalities in either the quality or quantity of respirations during sleep. Obstructive sleep apnea (OSA) is one type of SDB and is typified by repetitive cessations in breathing due to collapse of the upper oral airway during sleep. As a result, OSA induces a cyclic pattern of intermittent hypoxia-reoxygenation, arousal, increased inspiratory effort, sympathetic activation, and surges in blood pressure. Consequences of OSA consist of a number of cardiovascular diseases (CVD), including hypertension (Peppard et al., 2000), arrhythmias (Gami et al., 2007; Alonso-Fernandez et al., 2005; Gami et al., 2004), stroke (Yaggi et al., 2005; Dyken et al., 1996), coronary artery disease (Peker et al., 1999), sudden cardiac death (Gami et al., 2005) and heart failure (Bradley & Floras, 2003). Non-cardiac consequences include impaired cognitive functioning (Fulda & Schulz, 2003; Engleman & Joffe, 1999), gastroesophageal reflux disease, diabetes and dysphoric mood (Sforza et al., 2002; Aikens et al., 1999; Yu et al., 1999). Moreover, OSA is characterized by fragmented sleep, producing sleep
deprivation, daytime sleepiness, and altered quality of life (Aloia et al., 2004; Engleman et al., 1997).

By preventing upper airway collapse, continuous positive airway pressure (CPAP) is the treatment of choice for OSA. Acting as a pneumatic splint, CPAP mitigates the acute physiological effects of OSA. Treatment with CPAP has been shown to reduce blood pressure (Becker et al., 2003; Faccenda et al., 2001), arrhythmias (Gami et al., 2007; Kanagala et al, 2003), and daytime sleepiness (Weaver et al., 2007) and to improve left ventricular function (Kaneko et al., 2003) and cognitive functioning (Castronovo et al. 2006; Engleman et al., 1997). However, CPAP does not “cure” OSA, but instead requires a nightly commitment and behavioral adaptation to using the device.

CPAP use is notoriously sub-optimal and highly variable, making interventions to optimize adherence an important issue in sleep medicine (McArdle et al., 1999; Weaver et al., 1997). Non-adherence to CPAP may result from real or perceived difficulties related to its use with the most common complaints of nasal dryness and congestion, dry eyes, and noise levels (Engleman & Wild, 2003). Despite a number of device-related strategies to address these difficulties, such as bi-level pressure delivery, nasal “pillows” or humidification, adherence remains an issue.

Early studies reported high rates of patient adherence but relied solely on data derived from questionnaires or self-report (McArdle et al., 1999). Once CPAP devices with built-in timers became available, objective data revealed that subjective data was very unreliable and CPAP use was over-estimated (Dinges &
Weaver, 2007; Engleman et al., 1999), irregular (Weaver et al., 1997), and not at
prescribed levels (Hoy et al., 1999; Kribbs et al., 1986; Weaver et al., 1997).
Timers are now available on all CPAP devices, providing clinicians with objective
data that is easily retrievable. Even though 4 hours of CPAP therapy provides
benefit in sleepiness, snoring, quality of life, and cognitive function with carry-
over effects that continue for 3-4 hours (Kribbs, et al., 1986), there appears to be
a linear relationship between increasing CPAP use and better outcomes. The
importance of regular adherence to CPAP was highlighted in a longitudinal study
demonstrating a 5-year survival benefit for patients who used the therapy for 6 or
more hours per night, as compared to nonusers (Campos-Rodriguez et al.,
2005). Thus, the therapeutic bar for CPAP use is high and requires significant
behavioral dedication.

Adherence to CPAP and Behavior

As previously reported in Chapter 3, adherence rates for CPAP use are
established quickly, as early as the first night experience. Once established,
these patterns of behavior are not easily altered and are predictive of long-term
use (McArdle et al., 1999; Weaver et al., 1997). Importantly, even missing a
single night of CPAP results in the return of nocturnal apneas and daytime
sleepiness (Kribbs et al., 1993). Unfortunately no single intervention or
technological advancement has been identified to consistently improve
adherence, thereby placing increased attention on behavioral interventions.

Adherence requires decisions to be made about prescribed treatments –
specifically whether the advice given will be followed or not – making cognitive
functioning an important concern. Although aging is not synonymous with impaired cognitive abilities, estimates are that up to 17% of people age 65 and older experience some degree of mild to moderate cognitive impairment (Clark & McDougall, 2006). Previous reports have shown that cognitive dysfunction in older adults may be partially associated with the presence of sleep disordered breathing (SDB) and that an association exists between decrements in cognitive functioning and increased SDB severity over time (Zucala et al., 2003). This is also discussed in Chapter 2 of this dissertation.

As previously described, interventions targeting device-patient interfaces or technological advances in CPAP delivery have failed to demonstrate consistent improvements in use of the therapy. Behavioral interventions, such as education initiatives, have shown some promise (Haniffa et al., 2004). Changes in behavior are hypothesized to be a function of the perceived value of the outcome, the perceived risk of the outcome, or some combination of both (Wilson et al., 1988). The perception of risk is likely to be influenced by psychological traits, such as depression or dispositional optimism, and exert effects on decision-making. This may be especially pertinent with CPAP therapy, which requires significant behavioral change through nightly use and lifelong commitment to the cumbersome, obtrusive device.

**Decision-Making**

A decision is defined by the acts or options among which an individual must choose, the possible outcomes or consequences for those options, and the contingencies or probabilities of the outcomes based on the decision(s) made.
(Tversky & Kahneman, 1981). A decision maker will make choices consistent with his values, especially those that are relevant to that decision. Since few decisions in life can be made with absolute certainty, decision-making is largely a risky endeavor. Risk is used synonymously with the probability of some type of loss. Knowing the potential outcomes, their probabilities, and their values to the decision maker at the time the decision is made are critical considerations for adherence. Psychosocial factors, such as sleepiness, optimism, SE and depression, affect the interpretation of risk and ultimately decisions made about CPAP therapy.

**Sleepiness**

Sufficient sleep is not measured in absolute hours but, rather, in subjective terms of feeling rested and refreshed upon awakening. Individuals with OSA are sleep deprived and more likely to experience reduced attention spans, memory deficits and excessive daytime sleepiness. As described in Chapter 2, sleep deprivation has psychological ramifications for decision-making and adherence behaviors. As OSA and subsequent sleep deprivation worsen, so too do these symptoms. Greater sleepiness at baseline has been most consistently associated with increased CPAP use, assumedly through symptom reduction. However, knowing who will experience reduced sleepiness and derive benefit from CPAP at baseline is unknown.

**Dispositional optimism**

Recent studies have suggested that certain personality variables relates closely to how individuals interpret information and create expectations (Geers et
al., 2003). Dispositional optimism, or generalized positive outcome expectancies for the future, is a relatively stable personality trait that serves as a protective factor when difficulties in life, such as illness, are encountered (Carver & Scheier, 1998). Optimism appears to be a mediator in risk-taking behavior, as any potential loss is greater for someone in a positive affect state than for someone in a neutral or negative affect state. Optimistic expectancies, therefore, can increase the odds that a goal will be engaged, pursued, and attained, with positive implications for psychological health.

Optimists, as compared to pessimists, have been found to be more strongly persuaded by positively framed messages and less likely to be persuaded by negatively framed messages (Geers et al., 2003). Dispositional optimism has been shown to be positively associated with self-efficacy (SE) and inversely associated with depressive symptomology (Karademas et al., 2007). Recently optimism has been shown to be an independent marker for reduced cardiovascular mortality, even in those engaging in risky behaviors such as cigarette smoking (Giltay et al., 2006).

**Self-efficacy**

SE, or the belief in the capacity to engage in the behavior(s) that may lead to desired outcomes, impacts an individual's perceived ability to perform desired behaviors. SE influences behavior via perceived efficacy expectations and outcome expectations for the future. In particular, behavior-specific cognitions interact to create a commitment to a plan of action and, in doing so, directly persuade health-promoting behavior. Positive affective states impact perceived
SE by influencing action-oriented behavior and have been shown to promote cognitive functioning and adaptive coping (Bandura et al., 2003).

In the general population and in those with chronic disease, high SE is related to well-being, positive emotions and physical health (Lent et al., 2005; Kuijer & de Ridder, 2003). Because SE is potentially modifiable, interventions developed for those with chronic diseases have focused on enhancing SE with the goal of improving self-care, including adherence to prescribed therapies. Unlike costly medications or surgery, there are few risks associated with enhancing a patient’s confidence, resourcefulness, and psychosocial SE. SE has been studied in a variety of conditions, including CVD (Dracup et al., 2003; Clark & Dodge, 1999) and pulmonary disease (Clark & Dodge, 1999). Recent research in SE and CPAP adherence is encouraging, as greater SE has been found to be associated with improved adherence in first time users of the therapy (Olsen et al., 2008; Stepnowsky et al., 2007; Aloia et al., 2005; Wild et al., 2004; Stepnowsky et al., 2002).

**Depression**

The chronic sleep deprivation seen in OSA also can produce psychological distress and depression. In a longitudinal study, a causal link was established between depression and OSA, with odds for developing depression at least 1.6 times greater in individuals with OSA, even after adjusting for potential confounders such as age, body mass index, education, or history of CVD. (Peppard et al., 2006). Additionally, even higher rates of depression are seen with increasing disease severity (Peppard et al., 2006).
Treatment with CPAP has been reported to improve depressive symptoms by some (Flemons & Tsai, 1997; McMahon et al., 2003; Means et al., 2003; Engleman et al., 1997; Edinger et al., 1994), but not others (Yu et al., 1999; Borak et al., 1996). In addition, there appears to be no association between OSA disease severity and mood improvement post CPAP therapy. Instead, the severity of depression symptoms appears to influence the response to CPAP, as those with greater depressive symptoms reported greater improvements in mood post CPAP therapy (Schroder & O’Hara, 2005; Millman et al., 1989). One explanation may be that this mood disturbance may improve only when the depression is a consequence of OSA.

Although depression is known to negatively impact adherence in a number of conditions, depression’s effect on adherence to CPAP is less consistent (Wells et al., 2007; Ayalon et al., 2006; Lewis et al., 2004; Murray et al., 2002; Edinger et al., 1994). For example, one prospective study failed to find any association between depression at baseline and adherence at one month (Lewis et al., 2004), while others reported a negative correlation, as those with more depressive symptoms had lower adherence to CPAP (Ayalon et al., 2006; Edinger et al., 1994). However, it is important to note that a large number of studies investigating adherence in CPAP excluded individuals with clinical depression or included only those with normal depression scores at baseline.

In conclusion, inherent personality and behavioral traits influence decision-making, thus understanding how decisions are made is quite complex. Consciously or unconsciously, advantages and disadvantages of options are
considered before a choice is ultimately made. The behavioral and social sciences have long attempted to understand, explain or predict human decisions, yet it is only recently that “thought” has been considered as an important determinant of human behavior. Today it is more widely accepted that ideas and beliefs produce behavior. How information is presented provides a vital opportunity for persuasion with great implications for education, adherence, and patient outcomes.

**Prospect Theory**

The theoretical framework for this research study is Prospect Theory (PT). Developed by two Israeli psychologists, Daniel Kahneman and Amos Tversky, PT is a descriptive framework for the way people make decisions in the face of risk and uncertainty. Kahneman and Tversky assert that people simply do not calculate from purely financial perspectives, as economic models had previously claimed. Rather, people measure change - the perceived individual gains and losses - from a point of reference.

As the starting point for making decisions, the reference point is a psychologically neutral status quo. Yet it is highly malleable and may shift due to changes in health status or by the way choices are presented (Tversky & Kahneman, 1981). The subjective value for a particular choice is psychologically driven and derived from the current asset position, as determined by the reference point, and the magnitude of change, either positive or negative, from that reference point. As a result, any change in the status quo has a highly personalized meaning.
However, as seen in Figure 4.1, the value function is not linear, but rather is concave for gains and convex for losses. PT predicts that preferences for choices with uncertain or risky outcomes are affected by how information is presented (Tversky & Kahneman, 1981). While perceived outcomes from decisions can be viewed as positive or negative, negative outcomes are highly undesirable. Notably, gains and losses are not equal emotionally, and the intensity of displeasure resulting from a loss far surpasses that seen with a similar gain.

This “losses loom greater than gains” is the essence of PT (Kahneman & Tversky, 1979). PT predicts that preferences for a decision will depend on how the problem is presented. The first step in decision making is a mental accounting for the value of the decision under consideration relative to the reference point (Thaler, 1999). If the reference point is defined so that an outcome is viewed as a gain, decision makers will tend to be risk averse in order to avoid experiencing a loss. On the other hand, if the reference point is stated so that an outcome is viewed as a loss, decision makers may become more risk seeking and more willing to accept risk on the chance that they will regain what has been lost. Research has shown that those who are happy are more motivated to maintain that positive state, and increased avoidance of meaningful loss is evident (Isen, 2001; Isen et al., 1988). However this mind-set does not make individuals choose foolishly without regard to possible bad outcomes. Rather, negative outcomes may actually seem worse, resulting in behavioral adaptation to maintain an optimistic state.
It is important to acknowledge that information can always be presented in more than one way. Rhetoric may be packaged so that choices are stated in different ways, resulting in markedly different decisions being made. When logically equivalent choices are intentionally worded in order to facilitate some interpretation while filtering out others, a framing effect is observed. For example, a positive message framing effect occurs when the description of possible options for a decision is worded in terms of gains (using a positive frame format), rather than losses (using a negative frame format), thereby eliciting a systematically different choice.

Reducing risky behaviors has long been a focus for health and well-being and of healthcare. As previously described, PT asserts that people interpret information in terms of potential losses or gains from their reference point or, for this study, their current health status (Kahneman & Tversky, 1979). In situations considered risky, perceived losses from inaction should motivate behavioral change, more than the perceived gains that may result from taking action (Kahneman & Tversky, 1979). This premise was first evaluated in a study by Meyerowitz and Chaiken (1987) assessing the impact of negative- versus positive-framed education on performing breast self examination (BSE). As a behavior, BSE involves risk through its association with uncertain outcomes, since BSE is not done to prevent cancer but to detect it. Accordingly, women may experience immediate aversive consequences (anxiety and stress if a lump is found). In fact, fear of finding a lump is the most frequently reported reason for failure to perform monthly BSE (Meyerowitz & Chaiken, 1987). Consistent with
PT’s framing postulate and the assumption that losses are weighted more heavily than gains, Meyerowitz and Chaiken hypothesized that the loss-framed pamphlet, stressing the negative consequences of not performing BSE (more advanced disease, decreased survival), would be more effective in promoting adherence to BSE. Indeed, at 4 months, the loss-frame group manifested more positive BSE attitudes, intentions, and behaviors than the other groups (Meyerowitz & Chaiken, 1987). These findings have been replicated in other studies of disease detection behaviors, such as Pap smears (Rivers et al., 2005), HIV testing (Aponovitch et al., 2003), and mammography (Schneider et al., 2001; Banks et al., 1995).

In contrast, in examining the effect of message framing on health promotion behaviors, positive message framing, emphasizing gains associated with a particular activity, are more effective in promoting the desired actions. Health promotion activities, such as physical exercise (McCall et al., 2004), use of car seats (Christopherson & Guylay, 1981), smoking cessation (Wong & McMurray, 2002), gum care (Rothman et al., 1999), or use of sun screen (Detweiller et al., 1999), all known to reduce the possibility or progression of disease, are generally viewed as involving little risk to those engaging in the behavior.

A unique study by Rivers and colleagues (2005) examined message framing and education about Pap smears, either as a health promotion or a disease detection activity. Women being seen for non-gynecological reasons at a community health clinic were randomized to either gain- or loss-framed
information about Pap smears. As predicted, negatively framed messages, stressing the costs for not detecting cervical cancer early (a risky behavior by not having a Pap smear), and positively framed messages, emphasizing the benefits of preventing cervical cancer (a less risky behavior through having a Pap smear), were most effective in motivating women to have Pap smears (Rivers et al., 2005).

Hence, message framing exerts powerful effects in decision-making about health and healthcare. Discussing risks and benefits of treatment options is an important aspect of healthcare and is essential for creating “informed” patients. Yet, as shown above, the interpretation of risks or benefits can be manipulated simply by how information is presented, leading to markedly different interpretations and behaviors. While studied in health promotion and disease detection activities, evidence on message framing to prescribed therapies is lacking.

The purpose of this study was to examine the impact of message framing on adherence to CPAP therapy at 30 days. In an attempt to further understand treatment decisions made by patients, psychosocial and behavioral variables of interest included: sleepiness, dispositional optimism, SE, and depression. Specific aims of this study were:

1. To evaluate the impact of educational message framing on adherence to CPAP therapy at 30 days.
2. To examine 30-day adherence to CPAP in relation to change that may occur in the psychosocial variables between baseline and 30 days.
3. To investigate which variables (message framing, sleepiness, dispositional optimism, SE, and depression), when measured at 30 days, predicted adherence to CPAP therapy.

Methods

Research Design

The study used a 2-group, prospective, repeated measures design to evaluate the impact of message framing education on adherence to CPAP. The data of interest were collected prior to treatment with CPAP and after approximately 30 days of CPAP use at home. The dependent variable of interest was 30-day adherence to CPAP, with message framing, dispositional optimism, SE, depression, and sleepiness as key independent variables.

Sample

The convenience sample enrolled patients with a history of CVD who were newly diagnosed with OSA. Inclusion criteria were identified that would be most reflective of the population with high prevalence for sleep disorders and at increased risk for poor outcomes from non-adherence to CPAP therapy. Specifically, these included: adult patients (21-80 years old) with a history of CVD, newly diagnosed with OSA, no previous experience with CPAP, and prescribed treatment with CPAP therapy. While patients with an apnea/hypopnea index (AHI) greater than or equal to 15/hour are considered to be eligible for CPAP treatment, this study enrolled any patient that was prescribed CPAP therapy by the sleep specialist, regardless of the baseline AHI. Patients who were already using CPAP devices, had used CPAP before, had
previously been intolerant of CPAP, were diagnosed with primarily central sleep apnea, or were participating in another clinical trial were excluded from participation.

To reduce potential confounding, it was essential that usual care about CPAP therapy not be altered by this study. Therefore, the sleep specialist, sleep lab staff, and/or CPAP equipment providers continued to present standard information about CPAP therapy, including potential risks and benefits, in their customary terms and phrases. Patients were frequently instructed to use their CPAP devices for “most” or a “majority” of nights. When questions arose about CPAP during the weekly phone calls, explained below, patients were referred to their sleep physician.

Procedure

The study was reviewed by and in compliance with The Ohio State University Institutional Review Board. Participants were recruited from patients undergoing a scheduled second sleep study for the initiation and titration of CPAP therapy. OSA was diagnosed in all participants following a first in-laboratory overnight PSG study conducted at The Ohio State University Hospital East Sleep Laboratory, using standard scoring techniques. All sleep studies were scored and interpreted by an American Board of Sleep Medicine certified sleep specialist. Participants were enrolled between October 2007 and April 2008.

Sleep lab technicians, who had been educated on the research trial, reviewed the medical records of patients scheduled for a second sleep study for CPAP initiation and titration. Patients identified with a history of CVD were
approached about participating in this study by the sleep lab technicians. If a patient expressed interest, a member of the research team provided further information about the research protocol and answered all questions. A patient continuing to express interest in participating was then asked to read and sign the informed consent and HIPAA authorization documents.

Upon obtaining consent, a semi-structured interview was conducted to yield self-reported baseline data, including demographic characteristics, physical traits, and psychosocial variables. Information on OSA, such as AHI and lowest oxygen saturation, were retrieved from sleep lab documents from the diagnostic sleep study. In an attempt to further understand treatment decisions made by patients about CPAP, measurement of psychosocial variables of interest were conducted: sleepiness, dispositional optimism, depression, and attitudes toward managing the CPAP device (SE).

Following collection of these baseline data, participants were randomized to receive one of two educational interventions. This intervention consisted of a brief educational video about CPAP that was either framed positively, focusing on the benefits associated with CPAP use, or negatively, emphasizing the negative consequences that may occur if CPAP was not worn as directed (Table 3.1). Each subject viewed the video presentation on a one-by-one basis and then received a magnet reinforcing the assigned educational message. Participants were asked to place the magnet in a prominent location (i.e., on the refrigerator), so that they could refer to it several times a day. Additionally, once home CPAP therapy was initiated, subjects received a brief weekly phone call (lasting 1-2
minutes) for 4 weeks that reinforced the assigned educational message, using an IRB-approved standard script.

Usual procedures for the delivery of CPAP therapy to participants’ homes were maintained. Following approximately one month of home CPAP therapy, participants returned to their sleep specialist for routine care and follow-up. At this visit, the baseline instruments were readministered. Additionally objective adherence data on one-month home CPAP usage was retrieved from the device, while participants provided self-report information on subjective adherence.

Measures

Adherence. Objective data on adherence was collected from the CPAP device following the first 30 days of home therapy. Data were analyzed to determine the number of nights that CPAP was used for at least 4 hours. Since the majority of evidence defines CPAP adherence as an average use of CPAP for 4 hours or more per night for at least 4 nights per week to improve clinical outcomes, a usage index was calculated for each subject (number of days that CPAP usage was 4 or more hours divided by the total number of days studied) (Budhiraja et al, 2007). Values approaching 100% indicated greater adherence. Additionally, since some studies reported adherence dichotomously, the usage index was also used to categorize participants as being adherent or not. Those with a usage index of 70% or greater were classified as “yes,” whereas those with usage index less than 70% were classified as “no”.

Epworth Sleepiness Scale. The Epworth Sleepiness Scale (ESS) is a self-report instrument consisting of 8 questions that ask about the likelihood of falling
asleep in a variety of situations, some known to be soporific (lying down, watching television), others less so (i.e. sitting in traffic, during conversation) (Johns, 1991). The ESS requires subjects to use a 0-3 scale (0 = would never doze off during the activity, 3 = very high chance of dozing off during the activity) to rate the chance of dozing as part of his “usual way of life in recent times” (Johns, 1993). Potential scores range from 0 to 24. A score less than 10 suggests excessive sleepiness is not a problem, while 10 or more has a 93.5% sensitivity and 100% specificity in distinguishing pathologic from normal daytime sleepiness (Johns, 2000). In healthy normal patients, the ESS average score is 5, while those with OSA are 2 or more standard deviations above this, with scores of 14-16 (Engleman & Joffe, 1999; Johns, 1992). Internal consistency in 2 different groups of 150 patients with various sleep disorders had a Cronbach’s alpha of 0.88, while the Cronbach’s alpha for 104 medical students was 0.73 (Johns, 1992).

Dispositional Optimism. The Life Orientation Tool Revised (LOT-R) is an eight item self-report instrument (with 3 filler items) that uses 5-point Likert scales, ranging from “strongly disagree” (0) to “strongly agree” (4). Dispositional optimism is defined as the extent to which one anticipates positive outcomes for the future. Higher scores are associated with optimism and positive expectations for the future, and the range is 0-32. It has a reported test-retest reliability of 0.78 (Scheier & Carver, 1992; Scheier & Carver, 1985). In studies involving healthy individuals (Fournier et al., 2003; Jason et al., 2003), LOT-R scores have averaged 17, while studies of individuals with a chronic disease, such as CVD,
diabetes, or chronic fatigue (Sears et al., 2004; Fournier et al., 2003; Jason et al.,
2003), have reported average scores of 15 to 21.

Self-Efficacy. A subscale on self-efficacy (SE), from a questionnaire
developed specifically to evaluate social cognitive variables after initial exposure
to CPAP in individuals with OSA, was administered (Stepnowsky et al., 2002).
Subjects were asked the following questions: 1. I am confident that I can use
CPAP regularly, 2. I have the ability to use CPAP regularly, 3. I am confident I
will use CPAP regularly even if I do not feel like it, 4. I am confident I will use
CPAP regularly even if I experience uncomfortable side effects, 5. I can operate
the CPAP machine to make it more comfortable for me. A 5-point scale was
employed (0 = disagree a lot; 4 = agree a lot). Ranges are from 0 to 20, and
higher scores are indicative of higher levels of personal confidence in using
CPAP therapy. The SE questions have been validated and shown to be
positively associated with CPAP adherence at 1 month (Stepnowsky et al.,
2002).

Depression. Symptoms of depression were measured with the Center for
Epidemiological Studies Depression Scale (CES-D). The CES-D (Radloff, 1977)
is a 20-item self-report scale that is one of the most commonly used depression
screening tools in community-dwelling populations (Gotlib & Cane, 1989). In the
standard protocol for this screening scale, statements such as “I felt that
everything I did was an effort” and “people were unfriendly” are read by the
participants. They are asked to consider how often they felt this way during the
previous week and to respond to the statements on a 4-point scale from 0 (rarely
or none of the time) to 3 (most or all of the time). Four questions are reverse scored. The possible score range is 0 to 60 points with higher scores indicative of more symptoms of depression.

Statistical Analyses

Using SPSS version 16 (SPSS Inc, Chicago, IL), descriptive statistics, including percentages, means, and standard deviations were calculated to provide characteristics for participants with complete adherence data who were randomized to receive negative or positive educational messages. (Results for the total sample can be found in Chapter 3). In addition, to verify there were no between group differences based on assignment (positive or negative message framing), separate one way analyses of variance (ANOVA) or chi-square analyses were conducted to compare baseline data between groups. (Results also found in Chapter 3).

To answer the first research question evaluating the impact of educational message framing on adherence to CPAP therapy at 30 days, objective data on adherence were evaluated. To evaluate over-all CPAP adherence, data were analyzed both as a continuous variable (actual percentage of CPAP use for 4 or more hours over the 30 day period; the usage index) using analyses of variance (ANOVA) and as a dichotomized variable (yes or no, based on the usage index) using chi-square analyses. Subjective self-reports of adherence were tabulated as well.

To answer the second research question about changes in the psychosocial variables between baseline and 30 days, the data were first
analyzed using paired Student’s t-tests to identify significant changes from baseline. To assess the impact of any change on 30-day adherence, 2-group repeated measures ANOVA was performed with group assignment (positive and negative message framing) as the between-group factor and time (baseline and 30 day data) as the within-group factor. A second 2-group repeated measures ANOVA was then performed with adherence (usage index) as the between-group factor and time (baseline and 30 day data) as the within-in group factor.

To investigate which variables (message framing, sleepiness, dispositional optimism, SE, and depression), when measured at 30 days, predicted adherence to CPAP therapy at 30 days, linear regression analyses were conducted.

Currently there are no studies available using these same variables from which to base sample size nor any objective method for determining the impact of message framing on adherence in advance. Therefore, the sample size estimate was calculated as 30 per group assignment (10 for each of the 3 major variables of interest: educational message framing, depression, and dispositional optimism) and power of 0.8 (Cohen, 1988). Ten additional participants (17%) were added in case of attrition. Sample size was set at 70 participants. For clinical significance, the $P$ value was set a priori at 0.05, and all reported $P$ values are two-tailed.

**Results**

**Total Sample**

Seventy-six patients were approached about participation in this study, and 70 agreed to participate. Of the 6 eligible patients who did not agree to
participate and who are not included in further analyses, it is important to note that these individuals were slightly older (mean age 58.17 $\pm$ 9.2), had slightly lower AHIs indicative of moderate OSA (mean AHI 34.27 $\pm$ 33.83), and experienced less nocturnal hypoxia (mean oxygen saturation 81.33 $\pm$ 2.94), as compared to the study cohort (Chapter 2, Table 2.1 and 2.2). However, further interpretation of these data is beyond the scope of this study, as larger numbers are necessary for meaningful analysis.

Random assignment of the 70 participants providing informed consent resulted in 34 receiving the positive framed educational message and 36 receiving the negative framed educational message. Of the 70 agreeing to participate, final data on adherence were not available for 15 subjects. Of these, 3 did not tolerate CPAP titration, left during the second PSG, and did not return for any follow-up care thereafter (1 randomized to the positive and 2 randomized to the negative message framing groups). Eight additional participants received their home CPAP device but were lost to follow-up, as they did not return for subsequent care at the sleep clinic, despite multiple attempts to reach them via telephone and mail. Of these 8, 6 had been randomized to receive the positive framed message, and 2 to receive the negative framed message. The lost to follow-up rate was 18% for the positive message group and less than 1% for the negative message group; this difference was not statistically significant. In addition, adherence data were not available on 2 participants (1 in each group) who received an “older” CPAP device that did not store information on machine
use. Data for 2 participants could not be retrieved due to a computer malfunction (randomized to negative message group).

**Sample With Adherence Data**

Baseline characteristics of the 55 participants with adherence data are described in greater detail in Chapter 2. Selected baseline physical, psychosocial and disease severity variables, by group assignment, are located in Table 3.2. In summary, there were no significant group differences in any baseline variable based on group assignment or between those with and without adherence data. Over the course of 30 days, the mean percent CPAP usage for the study cohort was 52% (median 53%; range 0 to 100%).

Research question 1: Message framing and adherence. Group assignment at baseline demonstrated a significant correlation with dichotomized adherence at 30 days (chi-square=0.356, p=0.008, n=55). When defined as a continuous variable, adherence was significantly greater in the group assigned to receive negative message framing ($t =-2.36$, df=53, $p=0.030$). In this group (n=29), the average CPAP usage at 30 days was 63%, compared to 41% in the group randomized to positive message framing (n = 26). Similarly, when categorizing participants into those with or without a usage index of 70% or greater, there were no differences in baseline variables ($p=.708$), except for group assignment. For those receiving negative message framing, 55% (16 of 29) had a usage index of 70% or greater at 30 days. In contrast, 23% (6 of 26) of those who received positive message framing were adherent. This between-group difference was significant (Pearson’s chi-square=5.884, df=1, $p=0.015$).
Subjective data on adherence revealed that 92% of participants reported they were using CPAP, while objective data showed that only 44% of them had a usage index of 70% or greater. When asked if they were using CPAP for 4 or more hours per night and if they were using it 4 or more nights per week, over 80% indicated that they were adherent to both of these measures. However, objective data of the group revealed that only 49% had a calculated usage index of 70% or greater. No one reporting non-adherence to using CPAP was found to have a usage index of 70% or greater, when measured objectively.

Research question 2: Changes in psychosocial variables and adherence. With the exception of dispositional optimism (p=.158), statistically significant differences were seen in the psychosocial variables between baseline and 30 days in the entire sample. Specifically, sleepiness decreased (t =-3.393, df=53, p=.000), SE increased (t =2.635, df=48, p=.001), and depressive symptoms improved (t=-4.113, df=50, p=.000). When comparing the adherent versus non-adherent groups, higher SE scores were seen in those with a usage index of 70% or greater at 30 days (t=2.683, df=20, p=.014) and in those randomized to negative message framing (t=2.368, df=25, p=.026).

With group assignment (positive or negative message framing) as the between-group factor, 2-group repeated measures ANOVA revealed statistically significant within-subject effects between baseline and at 30 days for all the psychosocial variables except LOT-R. (Table 3.3). When examining the interaction effects of message framing and time, those randomized to negative messages had statistically significant changes in ESS, LOT-R, and SE scores,
compared to the positive message framing group. While ESS scores decreased, LOT-R and SE scores increased. In contrast, those randomized to positive message framing demonstrated a statistically significant reduction in CESD scores over the 30 days, as compared to the negative framing group which showed no interaction effects.

When adherence was used as the between-group factor (dichotomized as a usage index less than 70% or greater than or equal to 70%), 2-group repeated measures ANOVA revealed statistically significant within-subject effects between baseline and 30 days for all the psychosocial variables except dispositional optimism (Table 3.4). Over this time period, both sleepiness and depression scores decreased, while SE scores increased. When examining the interaction of adherence and time, participants with a usage index of 70% or greater had statistically significant improvements in SE. Additionally, statistically significant reductions in ESS and CESD scores were seen in both usage index groups.

Research question 3: Which variables predict adherence. When group assignment and 30-day SE were regressed on adherence, a significant model accounting for 24.2% of the variance in CPAP adherence resulted. (Table 3.5). The most important variable was SE at 30 days, accounting for 18.2% of the variance in 30-day adherence. Adding group assignment increased the variance explained by 6%, to 24.2%.

**Discussion**

The findings from this study add important information to the existing body of literature about CPAP adherence in 3 important ways. First, this study is the
initial to incorporate message framing into the education given to patients with a chronic disease about a prescribed therapy, explicitly CPAP. Secondly, participants receiving negative educational messages, emphasizing consequences of untreated OSA, were more adherent to CPAP at 30 days, as compared to those receiving positive messages. Additionally, this study is the first to examine the impact of dispositional optimism on adherence to CPAP. Finally, in individuals with chronic CVD and OSA, SE at 30 days contributed appreciably to the model of CPAP adherence.

As described in Chapter 2, group assignment explained 9% of the variance in 30-day CPAP adherence in a model examining variables that correlated with adherence (group assignment and first night use). In this chapter, group assignment continues to play a role, although somewhat less important. CPAP use was significantly increased in the group receiving negative message framing, whether analyzed as a continuous or dichotomous variable. It is postulated from these findings that individuals may be more adherent to CPAP when given education on the potential negative consequences that may result from untreated OSA, presenting an important opportunity to enhance adherence. However, this is contradictory to a systematic review of framing effects on physician opinions or treatment intentions (McGettigan et al., 1999). The authors concluded that message framing may influence clinical decision-making and perceptions of treatment value, recommending that evidence-based treatments should be presented in terms of gain, rather than losses, to physicians. It is extrapolated that physicians would then provide information to patients about
treatment recommendations from that same gain-framed perspective. The impact of negative message framing from this study suggests otherwise.

Paired-samples $t$ test analyses of these psychosocial variables identified improvements in the mean scores during the 30 days for the entire sample, regardless of group assignment or adherence, with the exception of dispositional optimism. (Table 3.6). This is consistent with evidence from other research using similar psychosocial variables (Stepnowsky et al., 2007; McFadyen et al., 2001). As expected, the increase in SE in both groups is consistent with previous research reporting higher SE after exposure to and personal experience with the CPAP device (Stepnowsky et al., 2007; Aloia et al., 2005). Unlike at baseline and as described in Chapter 2, a significant correlation existed between SE at 30 days and adherence at 30 days ($p=.01$) and was highest in those with a usage index of 70% or greater and in those randomized to negative message framing.

Also reported by others and as seen in this study, dispositional optimism is a stable personality trait. While there were slight increases in the LOT-R scores between baseline and 30 days, the range was similar at both time points (6-17), and the change was not statistically significant ($p=.391$). However, for those in the negative message group, the mean LOT-R increased and approached a statistically significant difference ($t=1.95$, $df=26$, $p=.06$). Interestingly, neither baseline nor 30-day dispositional optimism correlated with 30-day adherence. While dispositional optimism appears to be a mediator in risk-taking behavior, as optimists make efforts to avoid potentially negative outcomes, weekly calls reinforcing the educational messages appear to have affected this inherent
personality trait. Even though no significant correlations were seen between dispositional optimism and adherence this may, at least partially, explain why those receiving negatively framed messages about CPAP were more adherent to the therapy at 30 days.

Additionally, both SE and dispositional optimism are personality traits that are future-oriented and strongly associated with behavior and psychological well-being. Together, they likely create an informational processing bias for a more positive view of things to come. Following conclusions that SE was positively associated with optimism and inversely associated with depression, Karademas et al. (2007) suggested that individuals with poorer SE would experience more depression. However, when examining the lower quartile of SE data at both baseline and 30 days in the current study, there was no correlation between adherence and SE (Spearman’s rho=.041, p=.773 and Spearman’s rho=.118, p=.408, respectively). Nor were any correlations between optimism and depression evident at either time point.

Also as reported in Chapter 2 examining predictors of adherence at baseline, early experience with CPAP was predictive of later use in this study, and results expanded the early experience to now include the first night of home CPAP use. In particular, first night use, group assignment and baseline dispositional optimism contributed significantly to a predictive model of adherence. Results from this study now find that, while group assignment continues to be a factor, SE, measured at 30 days, is the most important variable for predicting adherence. This replicates work by Aloia et al. (2005) and
Stepnowsky et al. (2002) suggesting that behavior change principles are most predictive of long-term adherence only after patients have experienced CPAP. This finding may be especially important for those with OSA and CVD, as enhancing a patient’s self-care abilities, self-confidence, and SE, is associated with few risks, does not require additional medications, and appears to improve adherence.

Unsurprisingly, SE at 30 days correlates with first night use, supporting a reciprocal relationship between CPAP use and personal beliefs about using the therapy. However, 30-day SE also correlates with living alone (Spearman’s rho=.389, p=.005, n=51). These findings appear contradictory to studies by others that have found living alone to be associated with lower rates of adherence (Lewis et al., 2004; Weaver, 2003). While perceived social support has been found to be a mediating variable in a number of studies (Karademas et al., 2006), this support can be derived from sources outside of living arrangements, such as through close friends or colleagues. For individuals, the combination of high SE and a perception of strong support may serve to enhance optimistic expectations, behavior, and ultimately adherence.

Although not a specific aim of this study, it should be noted that self-reports of CPAP use by participants were over-estimated, as others have found. Possible explanations for this overestimation of use include cognitive error or response biases. As reported previously, objective CPAP adherence was sub-optimal in this study and is consistent with the findings of others. For example, in seminal work on objective adherence to CPAP, Kribbs et al. (1993) found that
less than 50% of patients had a usage index of 70% or greater at 30 days. Despite technological advancements and development of device-patient interventions, no single strategy has been consistently shown to improve adherence to CPAP. However, non-adherence is not unique to CPAP, but rather is a common feature in a number of chronic conditions. In a population with pre-existing CVD, adherence to the therapeutic regimen may be further challenged by the addition of a treatment known to present barriers to adherence.

Recent research has examined patients’ personal beliefs as determinants of medication adherence. In particular, beliefs about the necessity of the medication and concerns for adverse effects influence adherence (Horne & Weinman, 1999). When compared to patients with asthma, renal dialysis, or cancer, patients with CVD were significantly more likely to perceive that risks from medications outweighed benefits, resulting in reduced adherence to the prescribed therapies. As described earlier, decision-making is influenced by subjective value for an outcome relative to the reference point. Hence adherence decisions are based upon implicit cost-benefit analyses. If individuals do not perceive a treatment to be important or associate it with some type of loss, they will likely be non-adherent. This may be especially pertinent if the information given about the treatment is inconsistent or fails to include consequences for non-adherence. In the case of CPAP, which requires nightly behavioral commitment through the use of an obtrusive mask, perceptions of loss may outweigh perceived benefits or risks with untreated OSA.
Rather than being a constant state, health fluctuates over time. Thus the reference point and attitudes about health status are modified as health changes. Even though changes in health can be temporary, and may or may not provoke a change in the reference point, chronic diseases are apt to influence it. Chronic diseases are typically characterized by an insidious onset, have an unknown or lengthy duration, present functional limitations, and are not typically “cured.” Thus, as suggested by PT, chronic diseases are likely to produce a rightward shift in the reference point, as the individual psychologically adapts to the altered health status and perceives it less negatively over time (Treadwell & Lenert, 1999; Dolan, 1996).

Limitations

A number of limitations exist for this study. First, complete adherence data was available for only 79% of the participants enrolled in this trial and may have diminished the power. Secondly, while participants are being followed for 1 year, this report is based on data collected after only 30 days. Even though the initial experience to CPAP is predictive of longer term use, the impact of message framing over a longer time period is unknown. It is possible that rates of adherence will change with additional time. Additionally, medication histories were not collected as part of this study, so some participants may have been taking or started on anti-depression medications and may have confounded the CESD results. Finally, the information provided to patients from the sleep physician, sleep lab staff and respiratory company was not standardized and, through observation, was highly variable in respect to OSA, CPAP therapy,
adherence data collected by the CPAP device, and the consequences of untreated OSA. This educational issue may be especially relevant to CPAP therapy, given that it is obtrusive by nature and may present more barriers to adherence than other therapies, such as medications. As a result, individuals who receive inconsistent and/or inaccurate information about CPAP therapy may be more likely to perceive barriers, less likely to troubleshoot, and more likely to abandon the therapy.

Summary

Anything that can positively impact thinking and behavior has important implications for society. This is especially true in the domain of healthcare, where failure to follow medical advice and treatment recommendations are associated with high morbidity, mortality, and economic burden in the United States. Thus it is critically important to understand factors that influence patients’ decisions about following medical advice and treatment recommendations. How information is presented provides a vital opportunity for enhancing persuasibility with application to education, adherence, and outcomes for patients and healthcare providers alike. This may be especially pertinent for adherence to CPAP, a multi-dimensional treatment that includes technology, education, behavior and personality.

There is little doubt that positive- or negative-framed health information influences decisions made and behaviors chosen. Yet, the type and way that information is presented are important aspects of healthcare decision-making that are not routinely considered when teaching or discussing treatments with
patients. Replication of the findings of this study and further studies investigating message framing on adherence in chronic disease states are warranted.
References


In this model, decisions made are based on the current status quo (reference point; zero on the value scale) and the subjective assessment of possible outcomes, which are interpreted as either a gain or loss depending upon movement from the reference point. Possible options are considered, followed by the selection of the alternative with the highest subjective value. Notably, the relationship between losses and gains is not linear and reflects attitudes toward risk when losses or gains are involved. Individuals are often risk averse for gains and risk seeking for losses. The intensity of pleasure from a gain (a positive outcome) is less than the intensity of displeasure resulting from a loss (a negative outcome). Simply stated, losses hurt more than gains satisfy.
Positive Message Framing About CPAP Education
You have been diagnosed with Obstructive Sleep Apnea (OSA). OSA is known to be associated with heart disease, including heart failure, high blood pressure and sudden cardiac death. The treatment of choice for OSA is Continuous Positive Airway Pressure (CPAP) therapy.

- Using CPAP at least 4 hours per night will reduce your daytime sleepiness and give you more energy.
- If you use your CPAP at least 4 hours per night, you can experience benefits that may save your life.
- Using CPAP at least 4 hours per night will increase your chances of lowering your blood pressure.
- Medicare pays for your CPAP unit if you use it at least 4 hours per night.
- Using your CPAP at least 4 hours per night decreases the risk that your heart failure will get worse.
- Using CPAP at least 4 hours per night will decrease your chances of experiencing sudden death.
- You have heart disease. Do you plan to use CPAP to help prevent it from getting worse?

Negative Message Framing About CPAP Education
You have been diagnosed with Obstructive Sleep Apnea (OSA). OSA is known to be associated with heart disease, including heart failure, high blood pressure and sudden cardiac death. The treatment of choice for OSA is Continuous Positive Airway Pressure (CPAP) therapy.

- If you don’t use your CPAP at least 4 hours per night, you can’t treat your OSA and not treating OSA can cost your life.
- If you don’t use your CPAP at least 4 hours per night, you miss the chance to be less sleepy and have more energy.
- If you don’t use your CPAP at least 4 hours per night, you may increase your chance of your heart failure getting worse.
- If you don’t use your CPAP at least 4 hours per night, Medicare may bill you $1400. for the CPAP machine after 90 days.
- If you don’t use your CPAP at least 4 hours per night, you may decrease your chance of lowering your blood pressure.
- You may not decrease the risk that your heart disease will get worse if you don’t use your CPAP at least 4 hours per night.
- You have heart disease. Are you putting yourself at risk by not using CPAP?

Table 3.1. Positive and negative framed educational messages about CPAP.
<table>
<thead>
<tr>
<th></th>
<th>Adherence Data n (%)</th>
<th>Negative Message Framing n (%)</th>
<th>Positive Message Framing n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>55 (100)</td>
<td>29 (53)</td>
<td>26 (47)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>36 (65)</td>
<td>17 (59)</td>
<td>19 (73)</td>
</tr>
<tr>
<td>Female</td>
<td>19 (35)</td>
<td>12 (41)</td>
<td>7 (27)</td>
</tr>
<tr>
<td>Age, years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>55.4</td>
<td>56.5</td>
<td>54.3</td>
</tr>
<tr>
<td>Range</td>
<td>29-77</td>
<td>38-77</td>
<td>29-74</td>
</tr>
<tr>
<td>Body Mass Index Kg/m²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>34.03 ± 7.4</td>
<td>35.0 ± 7.5</td>
<td>32.9 ± 7.2</td>
</tr>
<tr>
<td>Range</td>
<td>22-56</td>
<td>22 – 56</td>
<td>24-50</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>20 (36)</td>
<td>10 (34)</td>
<td>10 (38)</td>
</tr>
<tr>
<td>Married</td>
<td>33 (60)</td>
<td>17 (59)</td>
<td>16 (62)</td>
</tr>
<tr>
<td>Widowed</td>
<td>3 (4)</td>
<td>2 (7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>18 (33)</td>
<td>8 (31)</td>
<td>10 (35)</td>
</tr>
<tr>
<td>Some college</td>
<td>15 (27)</td>
<td>8 (31)</td>
<td>7 (24)</td>
</tr>
<tr>
<td>College graduate</td>
<td>10 (18)</td>
<td>5 (19)</td>
<td>5 (17)</td>
</tr>
<tr>
<td>Post graduate</td>
<td>12 (22)</td>
<td>5 (19)</td>
<td>7 (24)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>40 (73)</td>
<td>20 (69)</td>
<td>20 (77)</td>
</tr>
<tr>
<td>African American</td>
<td>12 (22)</td>
<td>7 (24)</td>
<td>5 (19)</td>
</tr>
<tr>
<td>Asian</td>
<td>1 (2)</td>
<td>0 (0)</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2 (3)</td>
<td>2 (7)</td>
<td></td>
</tr>
<tr>
<td>Lowest Oxygen Saturation, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>77.8 ± 8.3</td>
<td>77.9 ± 7.7</td>
<td>77.7 ± 9.1</td>
</tr>
<tr>
<td>Range</td>
<td>50-92</td>
<td>50-90</td>
<td>59-92</td>
</tr>
<tr>
<td>Apnea Hypopnea Index, Average events/hr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>40.1 ± 27.3</td>
<td>42.4 ± 26.3</td>
<td>37.5 ± 28.6</td>
</tr>
<tr>
<td>Range</td>
<td>6.1-112.1</td>
<td>6.1 - 106</td>
<td>9.9 – 112.1</td>
</tr>
</tbody>
</table>

Table 3.2. Selected baseline demographic and disease severity characteristics of sample with adherence data by group assignment.
<table>
<thead>
<tr>
<th></th>
<th>Positive Message Framing Group</th>
<th>Negative Message Framing Group</th>
<th>Within-Subjects Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline 30 days Baseline 30 days</td>
<td>Time x Positive Message Framing</td>
<td>Time x Negative Message Framing</td>
</tr>
<tr>
<td>ESS</td>
<td>9.4 ± 4.7 8.3 ± 4.8</td>
<td>10.3 ± 5.0 7.4 ± 3.8</td>
<td>-2.0 ± .486 *</td>
</tr>
<tr>
<td>LOT-R</td>
<td>12.5 ± 2.6 12.5 ± 1.7</td>
<td>11.8 ± 2.7 12.7 ± 2.6</td>
<td>0.50 ± .345</td>
</tr>
<tr>
<td>SE</td>
<td>14.2 ± 3.0 15.2 ± 8.7</td>
<td>14.2 ± 3.6 15.6 ± 2.8</td>
<td>1.28 ± .492 *</td>
</tr>
<tr>
<td>CESD</td>
<td>15.8 ± 8.6 11.0 ± 7.6</td>
<td>15.4 ± 9.8 12.9 ± 9.4</td>
<td>-3.59 ± .872 *</td>
</tr>
</tbody>
</table>

Table 3.3. Descriptive summary and 2-group repeated measures ANOVA by group assignment (Mean ± SD for psychosocial variables; mean ± SE for within subject effects).

*p <0.05

EES, Epworth Sleepiness Score; LOT-R, Life Outcomes Tool Revised; CESD, Centers for Epidemiologic Studies – Depression; SE, Self Efficacy.
<table>
<thead>
<tr>
<th></th>
<th>Usage Index &lt; 70%</th>
<th>Usage Index ≥ 70%</th>
<th>Within-Subjects Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline 30 days</td>
<td>Baseline 30 days</td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td>Time X Usage Index &lt; 70%</td>
<td>Time X Usage Index ≥ 70%</td>
<td></td>
</tr>
<tr>
<td>ESS</td>
<td>9.67 ± 5.02</td>
<td>10.1 ± 4.7</td>
<td>-2.14 ± .519 *</td>
</tr>
<tr>
<td></td>
<td>8.3 ± 4.81</td>
<td>7.3 ± 3.4</td>
<td>-1.512 ± .647 *</td>
</tr>
<tr>
<td>LOT-R</td>
<td>12.0 ± 3.02</td>
<td>12.3 ± 2.1</td>
<td>0.527 ± .359</td>
</tr>
<tr>
<td></td>
<td>12.4 ± 2.4</td>
<td>12.9 ± 2.0</td>
<td>0.387 ± .486</td>
</tr>
<tr>
<td></td>
<td>0.527 ± .359</td>
<td>.387 ± .486</td>
<td>.667 ± .554</td>
</tr>
<tr>
<td>SE</td>
<td>13.5 ± 3.0</td>
<td>15.1 ± 3.6</td>
<td>1.327 ± .496 *</td>
</tr>
<tr>
<td></td>
<td>14.5 ± 3.3</td>
<td>16.7 ± 2.6</td>
<td>1.036 ± .650</td>
</tr>
<tr>
<td></td>
<td>1.327 ± .496 *</td>
<td>1.036 ± .650</td>
<td>1.619 ± .750 *</td>
</tr>
<tr>
<td>CESD</td>
<td>15.3 ± 9.1</td>
<td>15.9 ± 9.6</td>
<td>-3.66 ± .899 *</td>
</tr>
<tr>
<td></td>
<td>11.9 ± 8.7</td>
<td>12.0 ± 8.5</td>
<td>-3.37 ± 1.154 *</td>
</tr>
<tr>
<td></td>
<td>-3.66 ± .899 *</td>
<td>-3.37 ± 1.154 *</td>
<td>-3.952 ± 1.379 *</td>
</tr>
</tbody>
</table>

Table 3.4. Descriptive summary and 2-group repeated measures ANOVA by adherence as a usage index (Mean ± SD for psychosocial variables; mean ± SE for within-subject effects).

*p < 0.05

ESS, Epworth Sleepiness Score; LOT-R, Life Outcomes Tool Revised; CESD, Centers for Epidemiologic Studies – Depression; SE, Self Efficacy.
<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>Beta</th>
<th>t</th>
<th>p</th>
<th>Cumulative $R^2$</th>
<th>$R^2 \Delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-day Self-efficacy</td>
<td>4.557</td>
<td>.401</td>
<td>3.171</td>
<td>.003</td>
<td>18.2%</td>
<td>18.2%</td>
</tr>
<tr>
<td>Group assignment</td>
<td>17.82</td>
<td>.248</td>
<td>1.961</td>
<td>.056</td>
<td>6%</td>
<td>24.2%</td>
</tr>
</tbody>
</table>

Note: $R^2 = .242$, $F(2,48) = 7.674$; $p = .001$

Table 3.5. Linear regression using adherence as the dependent variable.
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS #1 – ESS #2</td>
<td>1.879</td>
<td>3.633</td>
<td>3.940</td>
<td>57</td>
<td>.000</td>
</tr>
<tr>
<td>LOTR #1 – LOTR #2</td>
<td>-.304</td>
<td>2.628</td>
<td>-.864</td>
<td>55</td>
<td>.391</td>
</tr>
<tr>
<td>SE #1 – SE #2</td>
<td>-1.189</td>
<td>3.374</td>
<td>-2.564</td>
<td>52</td>
<td>.013</td>
</tr>
<tr>
<td>CESD #1 – CESD #2</td>
<td>3.455</td>
<td>6.203</td>
<td>4.130</td>
<td>54</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 3.6. Paired sample *t* test analyses of psychosocial variables between baseline and 30 days for sample with adherence data.

ESS, Epworth Sleepiness Score; LOT-R, Life Outcomes Tool Revised; CESD, Centers for Epidemiologic Studies – Depression; SE, Self Efficacy.
The purpose of this dissertation has been to determine the impact of educational message framing on adherence to continuous positive airway pressure (CPAP) therapy in individuals with obstructive sleep apnea (OSA) and cardiovascular disease (CVD). Prospect Theory (PT) served as the theoretical framework for decisions made about adherence to CPAP. Importantly, PT predicts that decisions, and ultimately outcomes, are dependent upon how a problem or information is presented, or that decisions can be persuaded by how rhetoric is packaged.

This study enrolled a population with pre-existing CVD, newly diagnosed with OSA, and with no previous CPAP experience. CPAP, the gold standard for treatment of OSA, acts as a pneumatic splint to maintain a patent airway and requires the nightly application of a face mask for the delivery of therapy. Participants were consented at the time of treatment initiation, and prior to experience, with CPAP. To determine differences in adherence rates at 30 days, the intervention consisted of information about CPAP that was intentionally manipulated, using either negatively or positively framed messages. To eliminate potential confounding, the framed messages were supplemental to standard information already provided by sleep specialists.
The physical, cognitive and psychosocial alterations seen in OSA, as a consequence of sleep deprivation, have served as foundation for this dissertation research. Of particular interest has been adherence to the therapy and the decisions made about CPAP – simply, whether to use it as directed or not. Chapter 2 provided a theoretical review of the neurohormonal (NH) mechanisms common to both OSA and heart failure, as the final common pathway for all CVD, and proposed a NH synergism between the 2 chronic conditions. Key to treatment of both is NH blockade and adherence to the prescribed therapies, whether medications, CPAP, or both. Failure to take medications as directed or to use CPAP at least 4 hours per night results in inadequate NH blockade, leading to disease progression, worsening symptoms, and poor outcomes. A model was provided depicting the NH synergism and pathological links between OSA and heart failure and the ensuing cognitive impairment and altered decision-making that result in suboptimal adherence.

Despite 30-day findings of overall suboptimal adherence, this study does add important information to the existing body of literature about CPAP use in a number of ways. First, while previous evidence has demonstrated that patterns for CPAP use are established within the first 3-7 days of therapy, this dissertation research expanded the definition of early use to include the first night of home CPAP therapy. In a comparison of first night use between participants who wore CPAP for 4 or more hours the first night and those who did not, Chapter 2 discussed the statistically significant between-group difference found at 30 days, with first night users demonstrating greater adherence to CPAP (p<.001). Further analysis of the
data found that baseline self-efficacy was greater in those using CPAP the first night. Since behavioral patterns for CPAP use are established early, are not easily altered, and are predictive of long-term use, these results have important clinical implications. The ability to recognize and intervene during the initial home experience, before patterns of behavior have been firmly established, is necessary to enhance CPAP acceptance and use. Additionally, since self-efficacy is potentially modifiable, interventions proven to enhance self-efficacy in other chronic conditions, such as standardized education or frequent follow-up care, should be investigated in those who have been prescribed CPAP.

To date, no reliable or modifiable variables or technological advancements have been shown to consistently improve CPAP adherence. Hence, recent research has examined behavior and behavioral interventions as targets of enhancing adherence. Sleepiness and depression have been explored in studies of CPAP use, often with inconsistent findings for adherence. In this study, improvements in sleepiness and depression were seen for the entire sample between baseline and 30 days, regardless of CPAP use or group assignment. These findings are detailed in Chapter 3.

Previous evidence has shown that self-efficacy (SE), or the belief that an individual can engage in the behavior(s) that may lead to desired outcomes, is associated with improved CPAP adherence in first time users of the therapy and that SE increases following experience with the device. Chapter 3 provided evidence supporting the role of SE and further extends its applicability to individuals with both OSA and underlying CVD. In particular, baseline SE was greater in those
who are adherent to CPAP at 30 days, SE increased with experience with the
device, and SE was associated with greater rates of adherence at 30 days. Since
SE is potentially modifiable and enhancing SE is associated with few risks,
improving self-care abilities to optimize adherence are essential. This may be
especially pertinent in those with CVD, who already have complicated therapeutic
regimens, and for whom the addition of an obtrusive CPAP device may be
particularly burdensome.

Unique to the literature on behavior and adherence to CPAP from this
research was the influence of inherent personality, specifically dispositional
optimism. In Chapter 2, dispositional optimism, as measured at baseline, was
examined as a predictor of CPAP adherence. In a linear regression model that
included first night use, group assignment, and dispositional optimism which
explained 58% of variance to 30-day CPAP adherence, dispositional optimism was
significant (p=.026) and accounted for 5% of the variance. Chapter 3 then found
dispositional optimism to be a stable personality trait over the 30 days, when
measured across time in all participants. However, the negative message group
demonstrated greater improvements in dispositional optimism at 30 days,
approaching statistical significance (p=.06), as compared to those receiving
positively framed messages. Interestingly, neither baseline nor 30-day dispositional
optimism correlated with 30-day adherence.

There is substantial literature supporting the role of emotion and affect in
decision-making. In particular, dispositional optimism appears to be a mediator in
risk-taking behavior, as with the decision to use or not use CPAP, because
optimists are risk averse and make great efforts to maintain or improve their status quo. For this reason, negative outcomes seem worse to optimists, and increased behavioral adaptation is made. This may, at least partially, explain the major results of this research that follow below. Replication of these findings is necessary to further implicate and understand the influence of dispositional optimism, SE, and other inherent personality traits on adherence.

The major intent of this dissertation was to examine the impact of message framing on adherence to CPAP adherence. As detailed in Chapter 4, participants were randomized to receive either positively framed educational messages, emphasizing the good outcomes seen with CPAP use, or negatively framed messages, focusing on the deleterious consequences of untreated OSA. A review of the existing literature on message framing in health care revealed 2 important findings. First, there was an absence of literature examining message framing’s influence on prescribed therapies. Secondly, positive message framing has been reported to be more effective than negative message framing in promoting desired behaviors in health promotion activities, such as physical exercise or gum hygiene. Conversely, in disease detection activities, such as HIV testing or breast self examination, negative message framing is more effective than positive message framing for promoting desired behavior. For that reason, since CPAP therapy is intended to mitigate the adverse consequences of OSA, improve sleep deprivation, and prevent further cardiovascular deterioration, the initial hypothesis for this dissertation was that positive message framing would result in enhanced adherence to CPAP at 30 days. However, results demonstrated that the negative message
group had greater 30-day adherence (p=.015), as compared to the positive message framing group. While some have proposed that patients with multiple health problems and overlapping treatment regimens may be overwhelmed by negative health messages, leading to decreased adherence to CPAP, this study refutes that suggestion in a sample with pre-existing CVD. Perhaps this difference is related to how patients with a chronic disease evaluate the risk associated with the new diagnosis of OSA in relation to their current health status. In order to avoid additional losses in their health, physical functioning, or longevity, patients may be more receptive to, and persuaded by, negative messages. Thereby adherence to CPAP is enhanced. Based on these results, the model proposed in Chapter 1 was revised to reflect the inclusion of message framing, first night use, and SE. (Figure 4.1)

In summary, there is little doubt that gain- or loss-framed health information influences the decisions made and the behaviors chosen by people. How information is presented is an important new consideration when teaching or discussing treatment options with patients. Replication of this study in a larger sample is warranted and essential to verifying these findings. The insight gained should direct future work in enhancing adherence to CPAP through the use of framed educational messages. In addition, message framing should be studied in individuals without pre-existing CVD or other chronic diseases in order to discern differences in its impact on CPAP adherence. Importantly, such evidence would provide further insight and understanding of adherence decisions in those with single versus multiple chronic conditions. However, future studies of message
framing and adherence should be expanded beyond CPAP and should investigate adherence to other prescribed therapies, such as medications. Since the average 75 year old suffers from 3 chronic illnesses and takes 5 or more medications on a daily basis, there are vast morbidity, mortality, and societal inferences to enhancing adherence. Finally, message framing has extensive implications for altering the traditional patterns of patient education, not just for CPAP but for all prescribed therapies. Patients routinely make decisions about medical advice and treatment recommendations given to them based simply upon how information is presented. Increasing clinician awareness of their ability to persuade these decisions, using intentionally framed educations messages, appears to be a viable and straightforward approach to improving adherence and ultimately outcomes.
Figure 4.1. Revised model depicting the synergism between heart failure and sleep disordered breathing on cognitive functioning and adherence, with the addition of self-efficacy, first night use, and message framing as explanatory variables for CPAP adherence at 30 day.


Dinges, D.F., & Weaver, T.E. (2007). The critical role of behavioral research for improving adherence to continuous positive airway pressures therapies in sleep apnea. *Behavioral Sleep Medicine, 5*, 79-82.


differences in clinical presentation of patients with sleep disordered breathing. *Sleep Breath, 8*, 173-183.


Sforza, E., de Saint, H.Z., Pelissolo, A. Rochat, T., & Ibanez, V. (2002). Personality, anxiety and mood traits in patients with sleep-related breathing disorders: effect of reduced daytime alertness. *Sleep Medicine, 3*, 139-145.


