The Effect of Sleep Apneas on Cognition

Essay

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Introduction

Sleeping and dreaming always have been fundamental parts of human existence **(Dement, 2005)**. Only in the last half of this century, scientists and physicians attempted a systematic study of the biology and disorders of sleep. Within the past four decades remarkable advances in the neurophysiology of normal sleep and in circadian biology and the discovery of the genes that regulate these biological rhythms have provided a scientific framework for the elucidation of the etiology, pathogenesis, and potential treatment of sleep disorders **(Colten and Altevogt, 2006)**.

Sleep disordered breathing refers to a spectrum of disorders that features breathing pauses during sleep containing according to international classification of sleep disorders; central sleep apnea, obstructive sleep apnea and sleep-related hypoventilation/ hypoxemic syndromes.

Apneas or hypoapneas (a reduction without cessation in air flow or effort) typically result in abrupt and intermittent reduction in blood oxygen saturation, which leads to sleep arousals, often accompanied by loud snorts or gasps as breathing resumes. Episodic interruptions of breathing also frequently cause cortical and brainstem arousals, interrupting sleep continuity, reducing sleep time, and causing increased sympathetic nervous system activation **(Colten and Altevogt, 2006)**.

The most common disorder is characterized by obstructive apneas and hypoapneas. **(White, 2005)** and most of literatures and studies discuss its effect on cognitive functions.

Obstructive sleep apnea is a common disorder resulting from collapse of pharyngeal airways during sleep **(Woodson, 2003)**.

It was first described not by a clinician but by the novelist Charles Dickens who published a series entitled "Posthumous Papers of the Pickwick Club" in which he described Joe, a loud snorer who was obese and somnolent **(Dement, 2005)**.

Approximately 1 in 4 men and 1 in 10 women have at least 5 apneas or hypoapneas in each hour of sleep. In 4% of men and 2% of women are associated with excessive daytime sleepiness which, when combined with the breathing event in sleep, defines obstructive sleep apnea syndrome **(Lavie, 2005)**.

Obstructive sleep apnea has a wide range of effects on health as epidemiological studies reveal an association between it and cardiovascular system diseases especially myocardial infarction **(Marin et al., 2005)** and impaired glucose tolerance **(Ip et al., 2002)**.

Issues related to neurocognition and performance include those that deal with executive functions (e.g. decision making, planning, organization), working memory, sustained attention or vigilance and the response characteristics to stimuli that are presented repeatedly over time (including reaction time, failure to respond to a stimulus and responses made without a prompting stimulus) **(Sanders and Givelber, 2006)**.

Treatment of obstructive sleep apnea probably reverses the cognitive changes due to the disease, although there is some evidence that subtle cognitive abnormalities may persist **(Shneerson, 2005**). There are data supporting the concept that effective treatment of sleep apnea will reduce collision risk to normal **(Weaver and George, 2005)**.

Efficacy of Continuous Positive Airway Pressure (CPAP); one of the major lines of treatment of obstructive sleep apnea, in alleviating daytime sleepiness comes from randomized control trials and meta analysis **(Patel et al., 2003)**.

In this review, we would like to clarify that sleep fragmentation and hypoxemia due to sleep apnea commonly influence cognitive ability and daytime performance. Awareness of these impairments and prompt treatment will reduce burden of illness on the patient, reduce public risk, and minimize the physician's medical and legal risk.

Rationale

- Improve quality of life of patients with sleep apnea by early detection and management.

Aim of work

- Identify the relationship between sleep apnea and executive functions
- Determine the impact of excessive sleepiness associated with sleep apnea on cognitive functions
- Highlighting the importance of establishing the diagnosis is that sleep apnea is a treatable disorder with consequent improvement in daytime function and quality of life

Methodology (Procedure)

- In order to fulfill the aim of the work, a review of all available studies on "The effect of sleep apnea on cognition" will be done, and computerized searches of the literatures will be performed.
- The obtained findings will be categorized into different categories.
- These findings will be discussed.
- Following these steps, recommendations for further studies, and how we can help those patients will be generated.

INTRODUCTION

For centuries, sleep and dreams have been topics of interest; however, the modern scientific study of sleep began relatively recently.

Since the 1950s a convergence of findings from many fields (e.g., neurology, pulmonology, neuroscience, psychiatry, otolaryngology, anatomy, and physiology) have led to a greater understanding of sleep as a basic universal biological process that affects the functioning of many organ systems **(Shepard et al., 2005)**.

There are two types of sleep, non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep. NREM sleep is divided into stages 1, 2, 3, and 4, representing a continuum of relative depth. Each stage has unique characteristics including variations in brain wave patterns, eye movements, and muscle tone **(Carskadon and Dement, 2005)**.

In recent research the importance of sleep for the consolidation of memories has received an upsurge of attention. Indeed, memory consolidation may be the only function that eventually can explain the loss of consciousness experienced during sleep, based on the fact that the brain uses basically the same limited neuronal network capacities for the acute conscious processing of information and its long-term storage.

Acute processing and storing information might be mutually exclusive processes that cannot take place in the same networks at the same time **(Born et al., 2006)**.

In addition, many body system changes occur during sleep e.g. sympathetic-nerve activity, respiratory, cerebral blood flow, renal and endocrinal.

Generally, these changes are well tolerated in healthy individuals, but they may compromise the sometimes fragile balance of individuals with vulnerable systems, such as those with cardiovascular diseases **(Parker and Dunbar, 2005)**.

It is estimated that millions of people worldwide chronically suffer from disordered sleep and wakefulness, hindering daily functioning and adversely affecting health. The cumulative long-term effects of sleep deprivation and sleep disorders have been associated with a wide range of deleterious health consequences including an increased risk of hypertension, diabetes, obesity, depression, heart attack, and stroke. The public health burden of chronic sleep loss and sleep disorders is immense **(Colten and Altevogt, 2006a)**.

Issues related to neurocognition and performance include those that deal with executive functions (e.g. decision making, planning, organization), working memory, sustained attention or vigilance and the response characteristics to stimuli that are presented repeatedly over time (including reaction time, failure to respond to a stimulus and responses made without a prompting stimulus) **(Sanders and Givelber, 2006)**.

Sleep apnea refers to temporary cessation of breathing during sleep, and is a form of sleep disordered breathing. Analysis of breathing patterns permits classification of sleep apnea syndromes: obstructive, in which cessation of airflow is associated with persistence of diaphragmatic and intercostal muscle activity (i.e. respiratory efforts); central, in which cessation of airflow is associated with no respiratory effort; and a mixed pattern **(International Classification of Sleep Disorders, 2005)**.

Central sleep apnea syndrome (CSAS) is much rarer than OSAHS. It results from a transient reduction or withdrawal of central neural output to the respiratory muscles.

Obstructive sleep apnea (OSA) is a relatively common disorder that can have wide ranging negative effects on physical health, daytime functioning. OSA is characterized by interruption of normal sleep by repetitive complete (apneas) and/ or partial (hypopneas) cessations of breathing due to collapse of the upper airway **(Sanchez et al., 2009)**.

It was first described not by a clinician but by the novelist Charles Dickens who published a series entitled "Posthumous Papers of the Pickwick Club" in which he described Joe, a loud snorer who was obese and somnolent **(Dement, 2005)**.

Many studies note the adverse effects of OSA on physical, emotional, and intellectual capacities **(Aikens et al., 1999)**, as well as functional quality of life **(Baldwin et al., 2001)**. These studies suggest that the most serious symptoms that have been associated with OSAH include attention deficits, impaired concentration, and memory problems **(Engleman et al., 2000)**. That's why OSA is now recognized as a major public health problem due to its high prevalence, increased associated morbidity and mortality, high medical costs and increased public safety risk **(Kapur et al., 1999)**.

All of this may present legal challenges to practitioners. Whether a patient should be denied the right to drive or join certain jobs because of this risk is a matter of professional debate and legislative consideration.

Multiple lines of treatment for sleep apneas have been proposed e.g. positional therapy, continuous positive airway pressure (CPAP) **(Baldwin et al., 2001)**. Improvement of cognitive functions after treatment of sleep apnea specially with CPAP has been always an issue of debate, whether it has a long-term effect on health related quality of life (HRQOL), mental health (**Engelman et al., 2004)** and healthcare utilization **(Albarrak et al., 2005)**.

Introduction

This review will discuss the occurrence of cognitive and performance deficits in patients with sleep apneas, consider the scope of this problem, and explain the proposed etiologic mechanisms and methods of assessment. Finally different types of treatment will be discussed reflecting their effect on cognitive dysfunction.

CHAPTER I
Sleep and Cognition

Humans spend about one-third of their lives asleep, yet most individuals know little about sleep. Sleep is recognizable by its contrast to wakefulness. It is a state of reduced awareness and responsiveness, both to internal and external stimuli **(Velluti, 1997)**. It is an active process in which the significance of stimuli to the individual is interpreted and this determines whether arousal from sleep occurs or not. A second feature of sleep is motor inhibition. The sleeping subject appears quiescent, but some movements occur, such as rapid eye movements **(Shneerson, 2005a)**.

Sleep Architecture:

Sleep architecture refers to the basic structural organization of normal sleep. Through the time course of the twenty-four hour day on earth there is a pattern of cycling through wakefulness and the states of sleep. The cycling through wake and sleep is governed by a circadian pacemaker. This is a group of neurons closely associated with the optical system and located in the suprachiasmatic nucleus (**Carskadon and Dement, 2005)**.

There are two types of sleep; non-rapid eye-movement (NREM) sleep and rapid eye-movement (REM) sleep **(Colten**

and Altevogt, 2006a). Over the course of a period of sleep, NREM and REM sleep alternate cyclically. The function of alternations between these two types of sleep is not yet understood, but irregular cycling and/or absent sleep stages are associated with sleep disorders (**Zepelin et al., 2005**). Sleep cycles and stages were uncovered with the use of Electroencephalographic (EEG) recordings that trace the electrical patterns of brain activity (**Colten and Altevogt, 2006a)**.

There is probably a continuous tendency to move in or out of one of these three states (wakefulness and the two states of sleep) throughout the day and night. At any time, parts of the brain may be predominantly in, for instance, REM sleep whereas another part may be tending towards NREM sleep **(Shneerson, 2005a)**.

NREM and REM Sleep Cycles:

A sleep episode begins with a short period of NREM (stage 1) progressing through stage 2, followed by stages 3 and 4 and finally to REM. However, individuals do not remain in REM sleep the remainder of the night but, rather, cycle between stages of NREM and REM throughout the night.

NREM sleep constitutes about 75 to 80 percent of total time spent in sleep, and REM sleep constitutes the remaining 20 to 25 percent. The average length of the first NREM-REM sleep cycle is 70 to 100 minutes. The second, and later, cycles are longer lasting approximately 90 to 120 minutes (Figure 1).

In normal adults, REM sleep increases as the night progresses and is longest in the last one-third of the sleep episode. As the sleep episode progresses, stage 2 begins to account for the majority of NREM sleep, and stages 3 and 4 may sometimes altogether disappear (**Carskadon and Dement, 2005**).

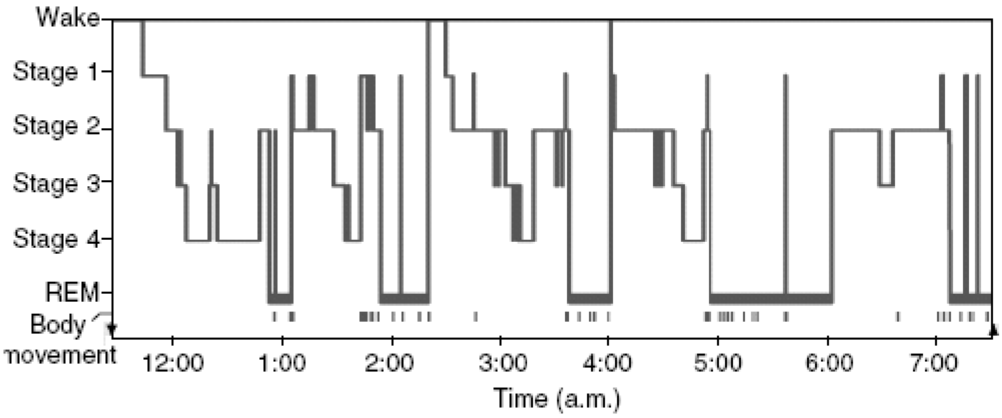

Figure (1): Progression of sleep states across a single night in young adult **(Carskadon and Dement, 2005)**

<u>NREM Sleep:</u>

The four stages of NREM sleep are each associated with distinct brain activity and physiology as the EEG shows patterns characteristic of the four NREM stages (Figure 2).