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Implications of Fatigue and Sleep Loss on Medical Professionals and Countermeasures to Prevent Fatigue

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Implications of Fatigue and Sleep Loss on Medical Professionals and Countermeasures to Prevent Fatigue

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Abstract

The number of hours worked per individual has long been limited by the law in many professional industries. Recent increases in the incidence of medical and diagnostic errors related to fatigue has led to an increased interest in health care worker fatigue. For human beings, functioning on a 24-hour basis poses unique physiological challenges. Acknowledging and managing these challenges can promote performance, productivity, and safety in 24-hour operations. Ignoring these factors can lead to decrements in human capability and to the potential for incidents and accidents that can result in tremendous societal and individual costs. Long duty hours, reduced sleep periods with limited recovery time, and shift work all contribute to impairments in physical, cognitive, and emotional functioning. Fatigue affects a healthcare provider's personal health and well-being, patient health and safety, performance of job-related tasks, and professionalism. As the incidence of medical errors due to fatigue increases, it is important to educate medical professionals on the effects of fatigue and measures that can be used to prevent or treat fatigue.

Information regarding the impact of fatigue and countermeasures to prevent fatigue in medical professionals will be gathered using a systematic literature review and published case studies. The areas of focus will include sleep cycles, the effects on provider and patient health, and ways to manage sleep loss and fatigue both for the healthcare provider and among management personnel.

The goal of this independent project is to provide information to currently practicing medical professionals in an attempt to increase the awareness of fatigue among the healthcare field. Primarily focusing on Certified Registered Nurse Anesthetists and Student Registered Nurse Anesthetists this project will be used to increase the knowledge base on how to prevent or treat fatigue that may lead to serious medical errors affecting healthcare provider and patient safety.

CHAPTER I

Purpose of the Study

The purpose of this study is to raise the awareness of fatigue among medical professionals, particularly Certified Registered Nurse Anesthetists (CRNAs), Student Registered Nurse Anesthetist's (SRNAs) and other anesthesia providers. It will also educate healthcare providers on normal sleep cycles and circadian rhythms, determine the impact of sleep loss and fatigue on the healthcare provider and the patient, specifically the implications of sleep loss on personal, social, and professional growth and development, and countermeasures to combat fatigue. An additional goal is to provide a framework to develop strategies for addressing and managing sleep loss and fatigue. A look at the designs, samples, and measures of research studies pertaining to this topic will help educate currently practicing health care providers with the tools to recognize and treat fatigue symptoms before serious medical errors occur.

Conceptual Framework

Nola Pender's Health Promotion Model is the guiding theory of this project. This model is a psychological look at how human beings perceive themselves, their health and their ability to change their lifestyles to promote health. This model is based on the idea that human beings are rational, and will seek their own improvement in health. But this rationality is dependent on things like self-esteem, perceived advantages of healthy behaviors, psychological states and previous behavior. The health promotion model (HPM) proposed by Nola J. Pender (1982; revised, 1996) was designed to be a "complementary counterpart to models of health protection." It defines health as a positive dynamic state not merely the absence of disease.

Health promotion is directed at increasing a person's level of wellbeing. The health promotion model describes the multi dimensional nature of persons as they interact within their environment to pursue health. The model focuses on the following three areas:

- · Individual characteristics and experiences
- · Behavior-specific cognitions and affect
- · Behavioral outcomes

The health promotion model identifies that each person has unique personal characteristics and experiences that affect their behavioral actions. The set of variables for behavioral specific knowledge and affect have important motivational significance. These variables can be modified through personal actions. The desired outcome is health promoting behavior, which is the end point in the HPM. Health promoting behaviors should result in improved health, enhanced functional ability and better quality of life at all stages of development. The final behavioral demand is also influenced by the immediate competing demands and personal preferences, which can derail an intended health promoting action (Marriner et al., 2005).

Definitions

Some of the terminology associated with fatigue and sleep loss can be hard to read and difficult to understand. Provided below is a list of definitions that depict the terminology of this topic.

Fatigue- physical and/or mental exhaustion that can be triggered by stress, medication, overwork, or mental and physical illness or disease

Micro sleeps- an episode of sleep which may last for a fraction of a second or up to thirty seconds. Often is the result of sleep deprivation, mental fatigue, depression, sleep apnea, hypoxia, narcolepsy, or hypersomnia. Micro sleeping can occur at any time, typically without significant warning

Circadian Rhythm- the internal body clock that regulates the 24 hour cycle of biological processes

Non REM sleep- period of low brain activity during which the regulatory capacity of the brain is actively ongoing and body movements are preserved

REM sleep- period of paralysis or nearly absent muscle tone (except for control of breathing), high levels of cortical activity that are associated with dreaming, irregular respiration and heart rate, and episodic bursts of phasic eye movements

Homeostatic drive for sleep- regulates length and depth of sleep

Sleep inertia-characterized by confusion, poor judgment, inappropriate decision making, and impaired recall of events occurring immediately on arousal

Significance of the Project

The increasing incidence of medical errors related to fatigue has brought forward the concern for patient and healthcare provider safety. Many perianesthesia nurses work nontraditional hours, staggered 10-12 hour shifts and on call hours. By working these different shifts, the body's circadian clock is disrupted. Research has shown that nurses who work non-day shifts commit more procedural and medication errors (Page, 2004). Human errors were believed to be a factor in 87% of 80 deaths attributable to anesthesia as reported by Dripps et al. (1961), 65% of 52 deaths as reported by Clifton and Hotten (1963), and Edwards et al. (1956) reported 83% of 589 deaths as a result of human error. Gravenstein et al. (1990) reported in their study of anesthesia providers that more than 50% of providers reported having committed an error in medical judgment that they attributed to fatigue. A study by Cooper et al. (1978) looked at the most common causes of medical errors caused by anesthesia providers and fatigue was listed as the fourth most common cause following inadequate experience, carelessness/inattention, and poor communication. Cooper, et al. (1978) estimated that human error played a role in more than 80% of anesthetic mishaps and that fatigue was an associated factor in 6% of reported critical incidents.

Fatigue caused by sleep loss and circadian disruption can decrease performance and reduce many aspects of human capability (Mitler et al., 2000). Known performance effects include reduced attention and vigilance, impaired memory and decision making, prolonged reaction time, and disrupted communication (Dinges et al., 1991). According to Jha, et al. (2001) after just one night of missed/interrupted sleep there is a 25% decrease in cognitive function and

a 40% decrease after two nights of missed/interrupted sleep. A common theme for the medical profession is first "do no harm", but inadequate sleep cycles and fatigued healthcare providers may be putting the patient at risk and causing harmful effects.

Assumptions and Limitations

For this review to be evidence- based, the studies must be reliable and valid. Assumptions of this study include that the tools and instruments used were created by experts in their field. Also, because of the relative prevalence of studies examining sleep loss and fatigue in the context of medical training, some portions of the literature reviewed involved physicians. The majority of these principles, however, apply to those in the nursing and advanced nursing profession as well.

Due to the fact that most of the studies utilized mailed questionnaires as a methodology, it may be considered that there was no systematic criteria used to select participants. Whether the sample received was representative of the general medical population is not known. Also, the findings are based on employee self report, and the reliability and validity of questionnaire items regarding sleep habits and medical errors due to fatigue have not been tested.

Besides questionnaires, a wide range of measures such as simple psychomotor tests and written exams were used. A handful of studies used healthcare-related tasks such as monitoring tasks or tracheal intubation. The lack of testing standardization limits the ability to quantify the impact of fatigue in healthcare settings.

Another limitation is that sampling bias cannot be ruled out because most response rates were low and the incentive to participate varied between facilities. Also, most of the studies did not differentiate specifically between CRNAs, Anesthesiologists, or other medical professionals.

CHAPTER II

REVIEW OF LITERATURE

Search Strategy

The review of literature began with electronic searches using online databases, including SCOPUS, CINAHL, Pub Med, Medline Plus, and the Cochrane database. The intention of the literature review was to obtain the most current research on the significance of sleep loss and fatigue in medical professionals with relation to adverse patient outcomes. The CINAHL and SCOPUS databases provided the majority of articles that were used in this review. Key terms used in the search were as follows: alertness, circadian rhythms, fatigue, fatigue countermeasures, performance, safety, sleep, medical errors, anesthesia errors, healthcare professionals, sleep loss of anesthesia providers, shift work, health effects on shift workers , nurse and patient safety, absence, sickness, and sleep deprivation, capacity for work, reduced efficiency, and psychomotor performance.

Basics of Sleep

Human beings are genetically hard-wired with a determined biological need for sleep and with a circadian pacemaker, located in the hypothalamus, that programs us to sleep at night and be awake during the day. The clock coordinates daily cycles in functions such as sleeping and waking, body temperature regulation, hormone secretion, performance capabilities, digestion, and mood (Kryger et al., 1994). The circadian clock keeps in tune with a person's local time because it receives its direction from the environment (i.e. sunlight and patterns of social

activity). Shift work or long hours require that the individual try to override this basic circadian pattern of sleeping during the night and being awake during the day. When a person suddenly changes the pattern, the circadian clock cannot adjust immediately. Individuals may be trying to work when the brain is programmed to sleep and vice versa. This can affect on-the-job alertness and performance (Rosekind et al., 1996).

The basis of sleep is composed of 2 distinct sleep stages: rapid eye movement (REM) sleep and non-REM sleep. Non-REM sleep composes 75-80% of sleep time in healthy adults. This is a period of low brain activity and body movements are reserved. Non-REM sleep is further divided into 4 stages.

Stage 1 sleep, often referred to as "light sleep", composes 2-5% of total sleep time and occurs at the sleep-wake transitions. Stage 2 sleep composes 45-55% of total sleep time and is characterized by bursts of rhythmic rapid EEG activity. Stages 3 and 4, approximately 3-25% of sleep time, are known as the "deep sleep" phases. These stages are when the person is most difficult to awaken and are considered the period of most restorative sleep (Owens, 2007).

REM sleep accounts for 20-25% of sleep time and occurs during 4-6 periods per night. During this stage there is paralysis or absence of muscle tone, except for the control of breathing. Also during this stage, there is a high level of cortical activity that leads to dreaming, irregular respiratory and heart rates, and bursts of eye movements that are the hallmark of REM sleep (Owens, 2007).

The balance between sleep need and quality and quantity of sleep obtained by an individual is termed sleep homeostasis. The homeostatic drive for sleep increases steadily during periods of wakefulness, reaching a maximum in the late evening. The circadian rhythm of sleep and wakefulness is characterized by predictable, clock dependent periods of maximum sleepiness (between 3-5 AM and PM) and maximum alertness throughout the day and night, occurring between 9-11AM and PM (Borbely et al., 2005). Carrier et al. (2000) stated that optimal mental performance requires a combination of adequate sleep and circadian wakefulness. Wehr et al. (1993) found that on average, the adult human requirement for sleep appears to be greater than 8 hours. The range of sleep requirement varies from 6-10 hours, and this requirement is genetically programmed and cannot be altered or trained to a different sleep need or pattern (Toh et al., 2001).

The homeostatic drive to sleep sharply increases when healthcare providers get less than the recommended 8+ hours/night of sleep, which results in an increased tendency to sleep and a decline in cognitive performance. The risk of an accident increases exponentially each hour after the ninth consecutive hour of work (Hanecke et al., 1998). Jewett et al. (1999) reported that deficits in attention and vigilance occur after 15-16 hours of continued wakefulness.

Current studies report that most adult Americans receive 1-1.5 hours less sleep per night than what is needed. The accumulation of this sleep loss produces a "sleep debt" (Carskadon et al., 1982). Most assume that they will "catch up on sleep' once the weekend arrives by sleeping in longer. These sleep debts cannot be repaid hour for hour, but through an increase in deep sleep or non-rapid eye movement occurring in stages 3 and 4 (Bonnet et al., 2000).

Along with the natural shortage of sleep per night, there are multiple other factors that affect medical professionals in the healthcare setting. These include frequent interruptions in on-call sleep, which leads to poor quality of sleep, shift work-related interruptions of normal circadian sleep wake cycles, and sleep inertia (Ackerman et al., 1995; Bruck et al., 1999). Medical professionals often also do not have adequate post call "recovery sleep" due to other work, family or personal obligations. Howard et al. (2002) found that those with inadequate recovery sleep reported levels of sleepiness comparable to those with sleep apnea or narcolepsy.

Effects of Sleep Loss and Fatigue on Safety

Sleep loss and disruption of circadian rhythm that results from demanding work schedules can lead to reduced safety, performance and health. Ignoring the effects of these physiologic disruptions will only increase the human and economic cost.

Fatigue related safety risks affect us at both individual and societal levels. Car crashes caused by falling asleep are a predictable consequence of sleep loss in healthcare workers (Marcus & Loughlin, 1996). According to the National Highway Traffic Safety Administration, fatigue contributes to 100,000 crashes annually that result in 76,000 injuries and 1,550 fatalities (Stutts, Wilkins & Vaughn, 1999).

The decline in psychomotor performance from sleep loss and fatigue has long been correlated to the impairments caused by ingestion of ethanol (Dawson & Reid, 1997). After 17 hours of continued wakefulness the hand-eye tracking tasks declined such that the impairment was comparable to a blood alcohol level of 0.05%, and after 24 hours of wakefulness the level of

psychomotor function was equivalent to a blood alcohol level of 0.1%, at or above the legal limit for driving (Howard, Rosekind, Katz & Berry, 2002). In a 2005 study by Arnedt, Owens, Crouch, Stahl & Carskadon, medical residents performance on a driving simulator was evaluated when rested, sleep deprived (post call), and moderately intoxicated. The results showed that in the sleep deprived conditions, performance was equal to or worse than in the intoxicated condition.

The cognitive demands of the anesthesia provider in the perioperative setting include continuous interpretation of data, evaluation of its relevance to patient status, and development and implementation of a plan to maintain homeostasis. These tasks require vigilance and are very susceptible to the effects of fatigue. When performance is affected by sleep deprivation or fatigue, the greatest decrease is in the immediate recall of information, short-term and long-term memory, reasoning, and the time for completion of tasks requiring reasoning (Gravenstein, Cooper & Orkin, 1990).

Several studies have shown the relationship between fatigue and decreased levels of alertness and vigilance, with the increased likelihood of errors that are associated with long work hours and on-call shifts (Rogers, Hwang, Scott, Aiken & Dinges, 2004). Gander, Merry, Millar & Weller (2000) reported that in a survey of anesthesia providers, 58% reported exceeding their self-defined limitations in providing safe anesthetics and 86% reported having committed fatigue related error.

Many medical errors or fatigue related accidents are due to healthcare providers falling asleep. They experience a performance gap that can be the result of a micro sleep. A significant

reduction in performance occurs which in turn can result in severe safety risks prior to and immediately after the occurrence of a micro sleep. During the micro sleep there is considerable slowed reaction time and cognition, lowered optimal responding and attention lapses, which all contribute to an increased opportunity for an error to occur. (Dinges, 1994)

Effects of Sleep Loss and Fatigue on Health

Sleep disturbances caused by sleep loss and fatigue can lead to many health problems. Sleep durations of fewer than 4 hours has been associated with obesity, cardiovascular disease, diabetes, and depression, each of which can lead to disabilities requiring early retirement (National Sleep Foundation, 2009; Patel et al., 2004). Trinkoff & Gieger- Brown (2004) reported that medical professionals whose schedule requires them to work >13 hours/day, have <10 hours off between shifts, and work on days off and mandatory overtime are more likely to have musculoskeletal injuries such as neck, shoulder, and back problems. Additionally, those staff members at highest risk for needle stick injuries are those who work long shifts, non-day shifts and weekends (Trinkoff & Geiger-Brown, 2007).

The immune and gastrointestinal systems can be affected after a few days of total sleep deprivation or several days of partial or fragmented sleep. Sleep deprivation of 4 hours per night for at least six nights has been found to have harmful effects on carbohydrate metabolism and endocrine functioning (Dinges, Douglas, Hamarman, Zaugg, 2001). At this degree of sleep deprivation there was abnormal glucose tolerance, increased cortisol levels and increased sympathetic nervous system activity.

Studies have been conducted that relate fatigue and sleep deprivation to mortality. An investigation done by the American Cancer Society found that men who reported obtaining sleep durations of less than 4 hours were 2.8 times more likely to have died within a 6-year follow-up as compared to men who obtained approximately 7.0-7.9 hours of sleep. Women with the same sleep habits showed a 48% increase in mortality risk (Kripke, Simons, Garfinkel and Hammond 1979).

Fatigue and Professionalism

The fatigue associated with working long hours is not only a concern for patient safety, but also seems to contribute to absenteeism and job dissatisfaction among medical professionals. Job dissatisfaction can lead to unprofessional behavior that ultimately affects patients and coworkers. In 2004, Papp et al., conducted a study of 22 focus groups of medical professionals and found that 21 of the 22 groups reported themselves as inattentive and brief in their interactions with patients and family members due to lack of sleep and fatigue. Most reported lacking time or energy to invest in "caring" for the patient and were just "managing" them. Sixteen of the 22 focus groups described a noticeable loss of empathy and concern for their patients.

Sleep loss and fatigue can negatively affect an employee's interactions and relationships with coworkers. Fatigue causes lack of interest in interacting with coworkers and may lead to outbursts that will be regretted at another time. Fatigue will also produce a decrease in worker productivity, leaving other co workers to pick up the slack. This could cause animosity among co- workers.

Sleep disturbances contribute to decreased employee productivity at a high cost to employers. Rosekind et al. (2010) conducted a study comparing four groups of employees, randomly selected from different facilities. The groups were classified into those who met qualifications for insomnia, those who met criteria for insufficient sleep syndrome (ISS), at risk (those who did not meet criteria for insomnia or have a medical condition that would produce insufficient sleep, but reported one or more complaints with sleeping), and good sleep (those who did not meet criteria for the other groups and reported no more than one sleep complaint).

Results from the study reported that the mean estimated annual cost per employee of sleep-disturbance-related at-work productivity loss was greatest for the insomnia group at $3156/employee. The mean figure for the ISS group was $2796/employee and for the at-risk group it was $2310/employee. The group with the lowest figure, the good sleep group, was estimated at $1293/employee. Work productivity loss due to insomnia, insufficient sleep and sleep disturbances will reach an estimated cost of $54 million annually.

Fatigue Countermeasures

Reduction in fatigue related risks and enhancement of patient and healthcare provider safety pose complicated challenges. There are many operational (i.e. job tasks, shift schedules), individual (i.e. age, experience) and physiologic factors that prevent a simple solution to this problem. Different facilities require different demands and people vary widely in their reaction to these demands. Sleep cycles and circadian pathophysiology change throughout the lifespan, making adaptation to alternating schedules more difficult as one gets older. Effective fatigue

management requires the use of personal strategies, whether used singly or in combination, to address varying work demands and needs.

The foundation to any change in fatigue related risks begins with education. It is critical that medical professionals have basic knowledge of sleep medicine to understand the physiologic factors that underlie fatigue. Most individual's perception of their own level of fatigue is poor. Individuals must develop the ability to recognize and then develop strategies to address sleepiness in oneself, as well as in coworkers to begin the battle against fatigue. Signs and symptoms of fatigue include: forgetfulness, poor decision making, slowed reaction time, reduced vigilance, poor communication, fixation, apathetic, lethargic, fluctuating moods, and nodding off.

Countermeasures to fatigue can be divided into two categories: preventative strategies (used before work and during rest periods) and operational strategies (those needed on the job). Preventative strategies are aimed at the causes of fatigue and are designed to help minimize sleep loss and circadian disruption caused by demands of work. The operational strategies temporarily relieve symptoms of fatigue and seek to minimize the effect of sleep loss and circadian disruption on alertness and on-the-job performance (Rosekind et al, 1996).

Preventative Strategies

One factor to reduce fatigue is to minimize sleep loss. The only effective intervention for sleep loss and fatigue is adequate sleep (Owens, 2007). Because the effects of sleep loss are cumulative, it is important to avoid starting a new work schedule with an existing sleep debt. It

is important to maintain a regular and consistent bedtime and wake time that is similar on both work days and days off. It is also helpful to develop a consistent bedtime routine that should begin approximately one half hour prior to sleep. A regular presleep routine can condition relaxation in preparation for falling asleep. This presleep routine breaks the connection between the psychological stressors of the day and the sleep period. Establishment of conducive sleeping conditions such as cooler room temperature, darkness, and low-noise levels is integral in obtaining adequate sleep. Sleep time needs to be given priority and kept as free as possible from other commitments and activities.

It is important to understand that it is impossible to force the body to sleep. The human body is programmed for certain periods of maximal alertness and sleepiness. If unable to fall asleep after 15-30 minutes, one should abandon the effort for the time-being and get out of bed. Quiet activities conducive to relaxation, such as reading, meditation or yoga, should be undertaken until sleepiness signals that it is time to go to bed and try again.

Naps have also been shown beneficial in preventing fatigue and improving alertness. Naps that occur just before work should be limited to 45 minutes. This will minimize the chance of entering deep sleep. Waking from a deep sleep can cause feelings of grogginess and disorientation for several minutes, termed sleep inertia (Rosekind et al., 1996). Of course, at other times, longer naps can be beneficial. Two hours will normally allow completion of one cycle through the different states and stages of sleep (Carskadon & Dement, 1994). Reduction in continuous wakefulness prior to a work period can be beneficial, so getting some sleep is better than getting none.

The most commonly used sleep aid in the United States is alcohol. Alcohol can promote relaxation and help one fall asleep, but it also produces easily disrupted, lighter sleep. It suppresses REM sleep in the first half of the night, leading to REM rebound and withdrawal effects in the second half. Withdrawal effects would include awakenings from intense dreaming, sweating and headaches (Zarcone, 1994). The amount of alcohol necessary to cause these adverse effects varies among individuals, taking into consideration gender (women are more susceptible), age and body mass. The human body can rid itself of alcohol at a rate of approximately 1 drink/hour, so it is advisable to stop drinking in sufficient time to allow the body's blood alcohol level (BAC) to reach zero before attempting to sleep. Even then, sympathetic arousal follows the decline of blood alcohol levels and may persist for 2 to 3 hours after the BAC returns to zero. Alcohol has also been associated with worsening sleeping disorders, including sleep apnea, and reduction in oxygen levels (Rosekind et al., 1996).

The most widely used stimulant to maintain wakefulness is caffeine. The pharmacologic onset of caffeine occurs within 15-30 minutes and its effects last about 3-4 hours and up to 10 hours in sensitive adults, although tolerance may reduce the effects of caffeine. The effect of caffeine depends on a variety of factors including habitual usage, body mass, and previous food intake. Howard et al. (2002) found that there is a significant increase in alertness and performance after ingestion of 200 mg of caffeine, with a positive effect occurring in a dose range of 100-600mg.

Tolerance to caffeine's stimulatory effects may occur with regular use. Overuse of caffeine may result in physical dependence characterized by withdrawal symptoms such as

headache, dysphoria and fatigue. Caffeine use may also lead to more fragmented sleep and decrease in total sleep time (Rosenthal, Roehrs, Zwyghuizen-Doorenbos & Roth, 1991). Caffeine has a variety of dose related side effects, such as heart palpitations and tremors, which might interfere with its usefulness at higher doses.

Nicotine and strenuous exercise prior to sleep may also interfere with conducive sleeping. Nicotine will produce the same stimulating effects as caffeine on nocturnal sleep, subsequent daytime drowsiness and performance. It is recommended to avoid nicotine at least 3 hour prior to attempting to sleep. Exercise has been shown to enhance deep sleep, which can be physically restorative. However, vigorous exercise results in physiologic activation, which can interfere with sleep. Exercise should be avoided within 2-3 hours of going to bed (Rosekind et al., 1996).

There has also been considerable research on how certain foods affect sleep. Foods rich in carbohydrates may induce sleep by elevating serotonin levels. Foods high in protein and certain amino acids are proposed ways to promote wakefulness by enhancing catecholamine activity. Attempting to go to sleep hungry or after eating too much will provide feelings of discomfort that may interfere with sleep. If hungry, a light snack prior to bed will be helpful. One should never go to bed hungry but should avoid heavy meals within 2 to 3 hours of sleep.

Operational Strategies

Once on the job, the range of available strategies to fight fatigue are limited. One useful strategy can be to engage in social interaction and conversations with co-workers. The individual must be active in the conversation, not just listening and nodding. Sleep deprivation

experiments have shown that physical activity is one of the most effective ways to combat sleep on the job. Isometric exercises and some stretching can be done in the sitting position, and even writing or chewing gum may help a drowsy employee stay awake (Rosekind et al., 1996).

If one uses caffeine on the job to help combat fatigue, it should be used at appropriate times throughout the day. Strategic caffeine use includes avoiding it when already alert, which is usually at the beginning of the daytime work period or just after a nap. Consumption should take place about an hour prior to known times of decreased alertness (i.e. 3-5 AM & PM). This may cause problems for those working night or call shifts who use caffeine during the 3-5 AM period. This may cause problems falling or maintaining sleep once home from work. In this case, the benefits and risks must be considered (Rosekind et al., 1996).

One operational measure that has been studied quite vigorously is on-the-job naps. Most of the studies include the field of aviation. The healthcare field has limited research in this area because of the concern and need for continuous patient care. Napping during work hours has also been correlated with a negative connotation and is often looked at as a sign of laziness and may be prohibited in the workplace. A joint study by scientists with the National Air and Space Administration (NASA) and the Federal Aviation Administration (FAA) examined the effectiveness of planned rest periods in improving performance and alertness. They examined two groups, one allowed a 40-minute nap opportunity (1 crew member at a time) and one group that did not receive adequate time for naps. Results showed that those who were allowed to sleep showed better performance and higher alertness than did the control group who had not

napped (Rosekind, Graeber, Dinges et al., 1994). Whether or not this would be beneficial or even possible in the healthcare field is unknown and less researched.

The issues regarding scheduling are the most complex to be addressed in the management of fatigue. Scheduling issues affect many aspects of an individual's life including resources, economics, and lifestyle. Some of the specific issues that need to be taken into account in scheduling proposals include length of shifts, off duty or minimum rest opportunities, effects of cumulative fatigue due to consecutive duty periods and reduced rest opportunities and recovery periods (Howard et al., 2002).

Studies done on scheduling and the effects of fatigue have reported negative outcomes due to the noncompliance of the participants. One investigation implemented a block of sleep time during the night for on-call staff in an attempt to minimize sleep loss. However, the on-call staff did not increase their sleep time because they chose to catch up on paperwork and other tasks in the department (Richardson et al., 1996).

Future Strategies to Combat Fatigue

There are a number of countermeasures currently under investigation that have not yet been shown to be practical or effective in operational settings. However, they do show the potential to reduce the sleep loss and circadian disruption caused by shift work. One idea that has received some attention is the use of bright light. Bright light has been proven to reduce the secretion of melatonin (a sleep-inducing hormone produced in the pineal gland), and it appears to have an alerting effect. The implementation of light therapy must be correctly timed for it to

have the desired effects. It is recommended to spend some part of the day outside in direct sunlight, however, exposure to bright light should be avoided in the evening before bed and encouraged in the morning upon awakening (Horowitz, Cade, Wolfe & Czeisler 2001).

Melatonin has also been under investigation for treatment of sleep deprivation and its ability to reset the circadian clock. It is currently not classified as a drug in the United States and is available in most health-food stores. The number of shift workers who are currently using melatonin is unknown and most are skeptical about its effectiveness and safety.

Melatonin has sleep promoting effects at doses of 0.3 mg-80mg throughout the biological day. Melatonin effects include shortening time of sleep onset, and self-rated sleepiness increases. Endogenous melatonin secretion increases close to the habitual sleep episodes, so one would assume that administration of exogenous melatonin within this period would improve the sleep inducing effects of melatonin, however, exogenous melatonin administration has given inconsistent testing results (Czeisler, Cajochen & Turek, 2000). The circadian phase-shifting effects of melatonin are dependent on the time of administration. Melatonin can cause adverse effects if administered within the wrong time of the circadian rhythm.

The potential for adverse effects among sleep deprived healthcare workers is serious. Fatigue management should be a shared responsibility. Medical professionals should come to work fit for duty, which includes obtaining sufficient sleep before shifts. Management personnel should ensure that appropriate scheduling practices are used to maximize alertness among staff.

The nature of anesthesiology is different from other healthcare specialties, as it is neither diagnostic or therapeutic, but requires continuous and careful monitoring of the patients and implementation of corrective actions when needed. It has been shown that anesthesiology departments have looked at its human errors more extensively than other medical or professional groups. Anesthesia is not without risks, although those risks have been significantly reduced since early studies in human error (Gunn, 2000). What makes human beings unique is their ability to make decisions and choices regardless if they are good or bad. Unfortunately, no system can be developed that is 100% able to prevent human error. Humans, therefore, will never be error free. As professionals, however, we are obligated to continue to search for better strategies and to utilize existing knowledge to improve the care we provide our patients and to enhance patient safety.

Chapter III

METHODOLOGY

Introduction

The incidents of medical errors attributed to fatigue are steadily increasing with increased patient loads, longer work hours and staff shortages. Most medical professionals are unaware and unable to recognize the signs of fatigue in themselves and coworkers. Most of the research on fatigue illustrates the structure of resident-physician's educational programs and the need for limited work hours. However, the treatment of fatigue is attributable to any profession, especially across the medical field. After an extensive literature review, it was deemed essential that this information, although limited, be presented to SRNAs and other CRNAs. This chapter will discuss the methodology of this project, encompassing the location, target audience, content, and results of the presented information.

Target Audience

The target audience for this project was CRNAs, CRNA program faculty, and SRNAs. The SRNAs are first-year students enrolled in the Masters of Science Nurse Anesthesia specialization at the University of North Dakota. There are currently 12 first year SRNA students in the 28 month program, which consists of 7 consecutive semesters. Also in attendance, were the program faculty, which consists of 3 currently practicing CRNA's. The information will also be targeted toward other practicing CRNAs, specifically anesthesia

providers at St. Mary's Medical Center of Duluth, MN., and other practicing CRNAs who attend the local state meeting. The practice by these CRNAs encompasses rural and urban settings.

Procedure and Plans

Once a comprehensive review of the literature was complete, the information was gathered and prepared into a formal presentation. The director of the Anesthesiology department at St. Mary's Hospital in Duluth, MN was contacted regarding an educational presentation to the CRNA staff and SRNAs completing a clinical rotation at the hospital. This presentation was given in the spring of 2011. The CRNAs and other attendees were very attentive, voiced interest in the topic, and asked appropriate questions. An evaluation tool was used to assess the effectiveness of the presentation (see Appendix B). The information will also be presented later at the North Dakota Association of Nurse Anesthetists' spring meeting in April of 2011. The information presented will be the project findings and offer an opportunity for open discussion and question-answer session on the treatment for fatigue among medical professionals (see Appendix A). All participants, including SRNAs, CRNAs, and CRNA program faculty, were encouraged to ask questions, contribute to open discussions, and voice comments.

Evaluation Plan

The University of North Dakota's guest speaker evaluation form (see Appendix B) was used to assess the effectiveness of the presentation. The form required participants to evaluate six statements on a one to five scale. If a score of one was chosen, the participant disagreed with the statement and a score of five would signify that the participant strongly agreed with the

statement. The evaluation form also provided space for additional written comments, suggestions for improvement, and speaker and program strengths. All participants were encouraged to truthfully complete the form and leave comments as needed.

Results

The expectations of this project and presentation were to increase knowledge and awareness of fatigue and it's treatments among medical professionals. The CRNAs and SRNAs openly asked questions regarding the topic. The complexity of the questions demonstrated their understanding of the topic and lead to further discussion and clarification where needed. The CRNAs and SRNAs gave positive feedback via the evaluation tool (See Appendix B). Most of the interest and discussion was on the topic of treating fatigue and the importance of hospital management being aware and active in staffing and scheduling. This information will also help SRNAs, once in the workforce, to learn ways to recognize and manage fatigue. It is imperative that CRNAs and SRNAs are aware and educated on the signs and symptoms of fatigue and how to prevent or treat fatigue to help avoid serious medical errors from occurring.

Chapter IV

RECOMMENDATIONS AND DISCUSSION

Implications for Practice

The medical profession consists of numerous specialties with varying work demands. To provide excellent, consistent and safe medical care to all patients, staffing is required 24 hours a day, seven days a week. With these schedule demands comes stress and fatigue. It is imperative for patient advocacy, that peers and students be educated on fatigue and its consequences and how to support coworkers who may be battling with this issue. Most importantly medical professionals must recognize and understand personal limitations when sleep deprived and plan accordingly. Sufficient scientific data and operational experience exists to recommend changes to reduce fatigue safety risks in anesthesiology (Howard et al., 2002). It should not take an adverse patient event for staff and management to implement fatigue countermeasures. Fatigue must be viewed as an unacceptable risk with dire consequences to our patients and ourselves (Sokolosky & Best, 2009).

Nursing Education and Research

Education regarding fatigue, it's consequences and countermeasures needs to be incorporated into educational programs such as: nurse anesthesia, medical school, resident training programs and into surgical settings. Education is the foundation for any change in fatigue-related risks (Papp, Miller & Strohl, 2006). Although further research is needed in peri-

anesthesia settings, current evidence does exist to enable policies and plans to be developed to combat the risks of fatigue (Ross, 2008).

Although residency programs are now required to implement education on the hazards of fatigue, there is limited evidence of this in other medical professions. Also important, is the need for continuing research in the efficacy of a more comprehensive fatigue management program that includes efforts to improve fatigue management knowledge, sleep hygiene, and changes in specific work-related behaviors (Scott, Hofmeister, Rogness, & Rogers, 2010). Further research on fatigue management needs to be implemented in order to help decrease the risk of adverse patient and provider outcomes.

Conclusion

There is no question that the problem of sleep loss and fatigue is one that impacts significantly on the professional and personal lives of healthcare professionals and of their patients. Disruption of the circadian clock is associated with decrements in performance of psychomotor tasks and with adverse health effects for personnel. Preparing for work by getting adequate sleep should be viewed by medical professionals as a responsibility to our patients. Fatigue may result in unintentional medial errors, motor vehicle crashes, mood disturbances and job burnout. We must obtain adequate daily (at least eight hours) and weekly recovery sleep (for sleep debt) as needed. We must understand our limitations when sleep deprived and plan accordingly. Fatigue must be viewed as an unacceptable risk with dire consequences to our patients and ourselves.

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Implications of Fatigue and Sleep Loss on Medical Professionals and Countermeasures to Prevent Fatigue

Tracie J. Christensen, SRNA

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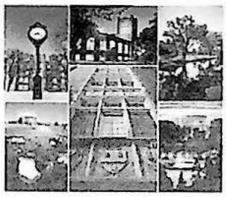

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Objectives

- Define the problem, purpose, significance, and methods used for this project.
- Review the basics of sleep
- Discuss the effects of sleep loss and fatigue on: Safety, Health, & Professionalism
- Identify current treatments/countermeasures used to combat fatigue

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Purpose

- To raise the awareness of fatigue among medical professionals, particularly Certified Registered Nurse Anesthetists (CRNAs), Student Registered Nurse Anesthetist's (SRNAs) and other anesthesia providers.
- To educate healthcare providers on normal sleep cycles and circadian rhythms, determine the impact of sleep loss and fatigue on the healthcare provider and the patient, specifically the implications of sleep loss on personal, social, professional growth and development, and countermeasures to combat fatigue
- To provide a framework to develop strategies for addressing and managing sleep loss and fatigue

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Problem

- The number of hours worked per individual has long been limited by the law in many professional industries.
- The risk of an accident increases exponentially each hour after the ninth consecutive hour of work (Hanecke et al., 1998)
- Recent increases in the incidence of medical and diagnostic errors related to fatigue has led to an increased interest in health care worker fatigue
- Long duty hours, reduced sleep periods with limited recovery time, and shift work all contribute to impairments in physical, cognitive, and emotional functioning.
- Fatigue affects a healthcare provider's personal health and well-being, patient health and safety, performance of job-related tasks, and professionalism

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Significance of the Study

- Human errors were believed to be a factor in 87% of 80 deaths attributable to anesthesia as reported by Dripps et al. (1961), 65% of 52 deaths as reported by Clifton and Hotten (1963), and Edwards et al. (1956) reported 83% of 589 deaths as a result of human error.
- Gravenstein et al. (1990) reported in their study of anesthesia providers that more than 50% of providers reported having committed an error in medical judgment that they attributed to fatigue

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Significance of the Study

- A study by Cooper et al. (1978) looked at the most common causes of medical errors caused by anesthesia providers and fatigue was listed as the fourth most common cause following inadequate experience, carelessness/inattention, and poor communication.
- Cooper, et al. (1978) estimated that human error played a role in more than 80% of anesthetic mishaps and that fatigue was an associated factor in 6% of reported critical incidents.
- According to Jha, et al. (2001) after just one night of missed/interrupted sleep there is a 25% decrease in cognitive function and a 40% decrease after two nights of missed/interrupted sleep

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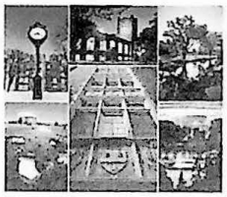

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Methods

- Extensive literature review of topic and additional areas of interest finding most current research and supporting data.
- Presentation to the Anesthesia Department at SMMC, Duluth,MN and CRNAs & SRNAs at NDANA spring meeting
- Conceptual framework used is Nola J. Pender's Health Promotion Model

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Methods

- Reviewed literature on:
  - Fatigue
  - Circadian rhythms
  - Fatigue countermeasures
  - Performance
  - Safety
  - Medical errors/anesthesia errors
  - Sleep loss of anesthesia providers
  - Health effects on shift workers
  - Sleep deprivation

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Basics of Sleep

- Wehr et al. (1993) found that on average, the adult human requirement for sleep appears to be greater than 8 hours.
- The range of sleep requirement varies from 6-10 hours, and this requirement is genetically programmed and cannot be altered or trained to a different sleep need or pattern (Toh et al., 2001).
- Current studies report that most adult Americans receive 1-1.5 hours less sleep per night than what is needed. The accumulation of this sleep loss produces a "sleep debt" (Carskadon et al., 1982).
- Most assume that they will "catch up on sleep" once the weekend arrives by sleeping in longer. These sleep debts cannot be repaid hour for hour, but through an increase in deep sleep or non-rapid eye movement occurring in stages 3 and 4 (Bonnet et al., 2000).

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Effects of Sleep Loss and Fatigue on Safety

- Car crashes caused by falling asleep are a predictable consequence of sleep loss in healthcare workers (Marcus & Loughlin, 1996).
- According to the National Highway Traffic Safety Administration, fatigue contributes to 100,000 crashes annually that result in 76,000 injuries and 1,550 fatalities (Stutts, Wilkins & Vaughn, 1999).
- The decline in psychomotor performance from sleep loss and fatigue has long been correlated to the impairments caused by ingestion of ethanol.
- After 17 hours of continued wakefulness the hand-eye tracking tasks declined such that the impairment was comparable to a blood alcohol level of 0.05%, and after 24 hours of wakefulness the level of psychomotor function was equivalent to a blood alcohol level of 0.1%, at or above the legal limit for driving (Howard, Rosekind, Katz & Berry, 2002).

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Effects of Sleep Loss and Fatigue on Safety

- Several studies have shown the relationship between fatigue and decreased levels of alertness and vigilance, with the increased likelihood of errors that are associated with long work hours and on-call shifts (Rogers, Hwang, Scott, Aiken & Dinges, 2004).
- Gander, Merry, Millar & Weller (2000) reported that in a survey of anesthesia providers, 58% reported exceeding their self-defined limitations in providing safe anesthetics and 86% reported having committed fatigue related error.

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Effects of Sleep Loss and Fatigue on Professionalism

- Contributes to absenteeism and job dissatisfaction among medical professionals
- In 2004, Papp et al., conducted a study of 22 focus groups of medical professionals and found that 21 of the 22 groups reported themselves as inattentive and brief in their interactions with co workers, patients and family members due to lack of sleep and fatigue.

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Effects of Sleep Loss and Fatigue on Professionalism

- Sleep disturbances contribute to decreased employee productivity at a high cost to employers.
  - Rosekind et al. (2010) conducted a study comparing four groups of employees, randomly selected from different facilities
  - Results from the study reported that the mean estimated annual cost per employee of sleep-disturbance-related at-work productivity loss was greatest for the insomnia group at $3156/employee. The mean figure for the ISS group was $2796/employee and for the at-risk group it was $2310/employee. The group with the lowest figure, the good sleep group, was estimated at $1293/employee. Work productivity loss due to insomnia, insufficient sleep and sleep disturbances will reach an estimated cost of $54 million annually

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Fatigue Countermeasures

- Minimize sleep loss
  - The only effective intervention for sleep loss and fatigue is adequate sleep (Owens, 2007)
  - Maintain a regular and consistent bedtime and wake time that is similar on both work days and days off
  - Develop a consistent bedtime routine that should begin approximately one half hour prior to sleep
  - It is important to understand that it is impossible to force the body to sleep

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Strategies to Combat Sleep Loss and Fatigue

- The most commonly used sleep aid in the United States is alcohol
  - Alcohol can promote relaxation and help one fall asleep, but it also produces easily disrupted, lighter sleep
  - The human body can rid itself of alcohol at a rate of approximately 1 drink/hour, so it is advisable to stop drinking in sufficient time to allow the body's blood alcohol level (BAC) to reach zero before attempting to sleep. Even then, sympathetic arousal follows the decline of blood alcohol levels and may persist for 2 to 3 hours after the BAC returns to zero

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Strategies to Combat Sleep Loss and Fatigue

- The most widely used stimulant to maintain wakefulness is caffeine
  - onset of caffeine occurs within 15-30 minutes and its effects last about 3-4 hours and up to 10 hours in sensitive adults, although tolerance may reduce the effects of caffeine
  - The effect of caffeine depends on a variety of factors including habitual usage, body mass, and previous food intake
  - Caffeine use may also lead to more fragmented sleep and decrease in total sleep time (Rosenthal, Roehrs, Zwyghuizen-Doorenbos & Roth, 1991).

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Strategies to Combat Sleep Loss and Fatigue

- Strategic caffeine use includes avoiding it when already alert, which is usually at the beginning of the daytime work period or just after a nap
- Consumption should take place about an hour prior to known times of decreased alertness (i.e. 3-5 AM & PM)
- This may cause problems for those working night or call shifts who use caffeine during the 3-5 AM period. This may cause problems falling or maintaining sleep once home from work
- Future Strategies currently under research are the use of bright light therapy and exogenous melatonin

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Strategies to Combat Sleep Loss and Fatigue

- Nicotine and strenuous exercise prior to sleep may also interfere with conducive sleeping.
  - Nicotine will produce the same stimulating effects as caffeine on nocturnal sleep, subsequent daytime drowsiness and performance.
  - It is recommended to avoid nicotine at least 3 hour prior to attempting to sleep.
  - Exercise has been shown to enhance deep sleep, which can be physically restorative. However, vigorous exercise results in physiologic activation, which can interfere with sleep.
  - Exercise should be avoided within 2-3 hours of going to bed (Rosekind et al., 1996).

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Summary

- Limited research/more research is imperative
- The foundation to any change in fatigue related risks begins with education
- Most individual's perception of their own level of fatigue is poor.
- Individuals must develop the ability to recognize and then develop strategies to address sleepiness in oneself, as well as in coworkers to begin the battle against fatigue.

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STUDENT SPEAKER EVALUATION FORM

Name of Student Speaker _____

Topic _____

Date of presentation _____

	Strongly Agree - Disagree				
Please place an X in the appropriate boxes	**5**	**4**	**3**	**2**	**1**
1. The objectives were clearly presented (if applicable)					
2. The content of the speaker's talk met my expectations.					
3. The speaker(s) presented the material in a clear and logical manner.					
4. The program length was appropriate for the subject matter.					
5. I would recommend this presentation to other students.					
6. Overall quality of presentation					

Speaker and program strengths:

Suggestions for improvement:

Additional Comments: