Sleep/Wake Patterns of Critical Care Nurses: A Pilot Study

BY

ASHA A. PEREIRA

A Thesis submitted to the
Faculty of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree of

MASTER OF NURSING

Faculty of Nursing
University of Manitoba
Winnipeg, Manitoba

The Faculty of Graduate Studies
500 University Centre, University of Manitoba
Winnipeg, Manitoba R3T 2N2

Phone: (204) 474-9377
Fax: (204) 474-7553
graduate_studies@umanitoba.ca

THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

*****

COPYRIGHT PERMISSION

Sleep/Wake Patterns of Critical Care Nurses: A Pilot Study

BY

Asha A. Pereira

A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirement of the degree

Of

MASTER OF NURSING

Acknowledgments

I would like to acknowledge the assistance and guidance provided by my thesis committee. Dr. Diana McMillan, whose patience, wisdom, guidance and pep talks were most appreciated; Dr. Wendy Fallis and her keen attention to detail, and Dr. Eleni Giannouli's enthusiasm and support, in spite of her incredibly busy schedule, each brought a particular expertise that helped me to grow personally and professionally.

I would like to acknowledge the financial contribution of the Dr. S. J. Winkler Memorial Award for Excellence in Scholarship and Professional Performance, and the College of Registered Nurses of Manitoba Foundation Award.

It is with gratitude that I recognize and thank all the healthcare professionals who took the time to share their knowledge and expertise with me throughout my graduate studies journey. Carol Ohren, (my preceptor), the nurses of A3 Stepdown, David McPherson (CVT Clinician), the nurses in pre-op assessment clinic at HSC, the nurses, surgeons and anesthetists in the Cardiac Surgery operating rooms at Health Sciences Centre and St. Boniface General Hospital and the staff of the Sleep Lab at St. Boniface Hospital who allowed me to look over their shoulders and ask a million questions. Thank you to Helga Bryant, Betty Lou Rock, Susan Fogg and Leanne Bernaerdt for your support. Sally Johnson, Sheila Bodner, Sandi Kowalski, Jannell Plouffe, Kim Falk, Carol MacKay, and Tara Rochester, for your support and your assistance in recruiting participants for this study, I am most grateful.

I wish to acknowledge the incredibly generous contribution of time given to me by the incredible nurses who participated in this study. The nurses in the SICU, MICU and PICU of Health Sciences Centre who wore the watches, filled out the surveys, kept track of their sleep or lack of and even recruited other participants; Thank you, thank you, thank you.

I would like to express gratitude to the members of the Faculty of Nursing, who have helped to enhance my education. Dr. Maureen Heaman, Dr. Roberta Woodgate and Dr. Susan McClement, your quiet cheerleading helped to sustain and encourage me to achieve my goal. Mary Cheung and Diane Cepanec's skill were most appreciated as my study was underway.

Thank you to the nursing staff of the Surgical ICU at St. Boniface, where I have spent the majority of my career, and where my passion for ICU nursing took root. The knowledge, proficiency and compassion demonstrated by this group of nurses helped to shape my career and heighten my expectations of nursing.

To the Board of Directors (2003-2008) of the Canadian Association of Critical Care Nurses, whom I had the pleasure and honor of serving with; thank you for your support and friendship.

My most amazing friends; Jennifer (Mohr) Moss, Barb Nault, Joanne and Bob Kolt, Lynda Mandzuk, Vanessa Buduhan, Tara Rochester, The Visser Family, Glenda Roy, Joy Mintenko, Grace MacConnell, Brenda Kline, Carol MacKay, Jody Arjoon, Kathy Doerksen, Judy Nixon, Janet Gray, Linda Jackson, Joanne Major, Michaele Rivet, the Advance Practice Nurses and Educators at the Health Sciences Centre; "Thank you" seems so inadequate, but know that your support has been invaluable. You have been my fan club, providing diversion when needed and believing in me, when I wasn't so sure. I appreciate this more than you can imagine.

Dedication

To My Family

Evelyn and Harry Edwards, Logan Edwards, Aunt Winifred Pereira, and Ena (Mom) and Dick Wells, for your quiet and unending support.

To my dad, Cecil Pereira (Ph.D) you set a high standard, teaching me that I can achieve anything, if I set my mind to it.

To my girls; Ally (Alexandra) and Marlo, you are the reason I wake up every day. Veronica, your free spirit and ability to thrive in spite of adversity is inspiring.

Grant; we have overcome a lot of hurdles and you carried the load, listened, supported, listened, read, listened. I could not have done this without your love and your constant and unrelenting belief in me. I want to stand on a mountain top and tell the world, that you take my breath away.

In loving memory of my baby brother

Jai Sam Pereira (June 21, 1967- June 27, 2001)

whom I miss every single day

Abstract

Disrupted sleep has implications for the health and performance of critical care nurses. This pilot study described sleep-wake patterns of critical care nurses practicing within a 12-hour shift work schedule.

The Revised Symptom Management Model (Dodd et al., 2001) guided this descriptive correlational study. A convenience sample of 18 critical care nurses from a large tertiary care hospital in mid-western Canada completed subjective measures of sleep/wake (Sleep Log, Sleep Timing Questionnaire, Pittsburgh Sleep Quality Index, demographic questionnaire), and daytime sleepiness (Epworth Sleepiness Scale), and an objective measure of rest/activity (Actigraphy) for a period of 10 days.

Subjects reported high daytime sleepiness, poor sleep quality and shortened sleep periods. A positive relationship between the sleep/wake and rest/activity measures was found. This study provides insight into the disrupted sleep/wake patterns of critical care nurses and has implications for the health and safety of nurses and the patients for whom they care.

Table of Contents

List of Figures

List of Tables

Chapter 1

Statement of the Problem

Sleep is an important physiologic need. Patients in critical care units, as well as the nurses who care for them, require sleep in order to function properly. Sleep is necessary for effective cognition, judgment, logic, complex decision making, memory, information management, communication, and vigilance (Stokowski, 2004). According to Lee (1997), healthy adults spend as much as one-third of their lives sleeping, yet only notice or think about their sleep if it is inadequate or disrupted.

Sleep can be disrupted for a variety of reasons. Healthy individuals who have experienced disrupted sleep often complain of symptoms such as fatigue, irritability, problems concentrating, and changes in their personality. The reasons for sleep disruption are numerous and among the contributors are gender (Ruggiero, 2003), the provision of child care (Ruggiero, 2003; Trinkoff, Geiger-Brown, Brady, Lipscomb & Muntaner, 2006), a snoring or restless bed partner, lack of social support, and shift work (Lee, 1997; Ruggiero, 2003; Stokowski, 2004).

Shift workers are prone to many of the symptoms of sleep disruption because of their irregular and often long hours of work. One group particularly affected by shift work is nurses. Sleep disruption is a side effect of career choice and one that is affected by the round the clock nature of the work schedule. According to Sveinsdóttir (2006), the underlying assumption of studies on the effect of shift work on performance, and physical and psychological well-being is that a disruption of the circadian rhythm, coupled with interference with daily routines at work and home, such as commuting, eating, and sleeping, may have detrimental effects on the physical and/or mental health of the nurse.

Long-term fatigue, sleep disorders, physical and psychological ill health, and absenteeism are among the detrimental effects attributed to shift work (Smith et al., 2005).

The issue of patient safety, having reached the national agenda, has resulted in a plethora of research being conducted to ensure the safety of patients within the healthcare system. According to Scott, Rogers, Hwang and Zhang (2006), "although healthcare providers are not expected to make errors, mistakes do occur, and some mistakes have resulted in serious injury or death" (p. 30). Organizations like the Institute for Healthcare Improvement (IHI) in the United States, the Canadian Intensive Care Collaborative, and Safer Healthcare Now! Campaigns in Canada all aim toward improving the lives of patients through quality initiatives that focus on patient safety. As these organizations have focused attention upon the potential hazards that patients in hospital encounter, many have begun to look at the entire system and changes that can be made to benefit both the patients and those who provide care within the system.

One area that is gaining increasing attention is the effect of sleep deprivation upon performance. Lack of sleep can have serious consequences, both for the person suffering from lack of sleep and for those around them. According to Hughes and Rogers (2004), "the effects of sleep loss, even as little as one hour lost daily, accumulate, resulting in decrements in neurobehavioral performance" (p. 36). This issue becomes particularly significant for those who are being cared for by clinicians suffering from the effects of deprived sleep. Numerous researchers have studied the effect of prolonged work hours on resident physicians, performance, and the effect on the care patients receive as well as the impact upon the physicians themselves. Rollinson et al. (2003) found that interns who worked the night shift in the emergency department demonstrated a significant reduction in their ability to visually retain details and to concentrate on small tasks, which is very important when caring for many patients at the same time. Post-call performance of medical residents who had worked a heavy call schedule were studied and found to be comparable to impairment associated with those who had elevated blood alcohol levels (Arnedt, Owens, Crouch, Stahl & Carskadon, 2005). Gaba and Howard (2002) suggest that medical residents in the United States are working far beyond the limits that are deemed acceptable by other sectors in society and believe that this practice is "incompatible with a safe, high-quality health care system" (p. 1254). Sleep deprivation and fatigue in physicians may be factors in the occurrence of medical errors and may compromise patient care (Weinger & Ancoli-Israel, 2002).

Within the area of safety research, focus has now shifted toward the prolonged work hours of nurses (Gold et al., 1992; Lee, 1992; Rogers, Hwang, Scott, Aiken, & Dinges, 2004; Scott et al., 2006; Stokowski, 2004; Trinkoff et al., 2006). The majority of nurses working in the critical care units in the largest healthcare facility in Manitoba work 12-hour shifts. The nurses who work an 8-hour shift are generally charge nurses or nurses who are working a shift outside of their normal schedule. Hughes and Rogers (2004) ascertain that sleep deprivation compromises the health of nurses and puts the patients at jeopardy. They suggest that "working too many hours and sleeping too few results in profound sleepiness that can deteriorate a nurse's alertness, productivity and safe patient care" (2004, p. 36). Rogers et al. (2004) found that nurses who work extended hours are more likely to make errors that adversely affect patient safety.

The potential for critical care nurses to work numerous shifts in a row and to extend the hours of work beyond the regular work week is continuing to increase as the shortage of critical care nurses in Canada, in fact the world, reaches dangerous levels. The Canadian Nurses Association predicts a nationwide shortage of 78,000 registered nurses by 2011 and 113,000 by 2016. Within critical care alone, 31% of nurses were eligible for retirement in 2005. As the population ages, so too do the care givers, leaving those who continue to work at the bedside numerous opportunities to work as many hours as desired in order to meet demands.

There are few studies that look at the effect of shift work on critical care nurses specifically, yet this group of nurses has a relatively constant work load, regardless of whether they work during the day, evening, or night shift. In addition, they are required to remain highly vigilant during their shift, regardless of time of day or night because of the increased acuity of their patient population and the rapidly changing conditions of these patients.

It is important to determine if critical care nurses who work 12-hour shifts, including at least some night shifts (i.e., straight night shifts or rotating day and night shifts) experience any symptoms of sleep deprivation or if they even perceive that they are sleep deprived. A symptom, according to Dodd et al. (2001), is "a subjective experience reflecting changes in the biopsychosocial functioning, sensations, or cognition of an individual" (p. 669). Symptoms are important cues that bring attention to problems that are experienced by an individual and are often the impetus for interventions to counteract any effects that may be experienced. If the symptom experience is negative, it can cause distress and this has been associated with a decrease in functional status, and cognitive ability, and may cause progression of disease (Armstrong, 2003).

Thus, given the alarming number of reports warning that sleep deprivation is hazardous to the health of nurses and their patients, it is necessary to establish whether critical care nurses are experiencing any negative symptoms related to changes in their sleep-wake patterns. If there are negative symptoms related to changes in sleep-wake patterns, it may become necessary to develop management strategies to cope with any effects that may be experienced. Specifically, it is important to gain a better understanding of the sleep and wake patterns and potential sleep deprivation or sleep disturbance impact of nurses engaged in night shift work on critical care units.

Background

Critical care nurses: Critically ill patients require 24-hour nursing care. Critical care nursing can be defined as the care and treatment of critically ill patients (Canadian Association of Critical Care Nurses, 2003). Critical care nurses deal specifically with human responses to life-threatening problems. A critical care nurse is responsible for ensuring that acutely and critically ill patients and their families receive optimal care (American Association of Critical Care Nurses, 2006). This generally encompasses nurses who work in intensive care units, whether specialized or generalized, in post anesthesia recovery rooms, in emergency rooms, in renal dialysis environments, and even those who work with air medical and retrieval teams (Williams et al., 2001). In order to meet the health needs of these patients, nurses working in a critical care setting are required to perform a variety of work schedules to ensure that 24-hour nursing care is available. They provide "the bulk of the care to patients with oftentimes unstable conditions and must therefore be alert to subtle changes in patients' conditions, perform accurate clinical assessments and respond in an expedient manner" (Scott et al., 2006, p.

35). Critically ill patients are defined by the American Association of Critical Care Nurses (AACN), as those patients who are at high risk for actual or potential life-threatening health problems. The more critically ill the patient is, the more likely he or she is to be highly vulnerable, unstable and complex, thereby requiring intense and vigilant nursing care (AACN, 2006). For the nearly 17,000 Canadian nurses working in critical care (Registered Nurses Database, Canadian Institute for Health Information, 2006), shift work is a component of their practice.

Shift work: Shift work is defined by the National Sleep Foundation (2005) as a work schedule that falls outside the typical '9 to 5' business day. In nursing, the 24 hours of the day are usually covered by three 8-hour shifts; days, evenings and nights. Some shifts are 12 hours in length (days and nights). These 12-hour shifts are scheduled in conjunction with the 8-hour shifts so that there is adequate staff available for the busiest times of the day or night. In addition, there are part-time shifts used to overlap the 8-hour shifts to ensure safe coverage of patients. In order to decrease the requirement for overtime and extended hours and to make certain adequate staffing is available to care for patients, the majority of critical care units have altered the work schedules to increase the number of 12-hour shifts. The rationale for this is to increase the continuity of care for patients while decreasing the number of unscheduled shifts, and nurses, required. However, the 12-hour shifts are often extended to accommodate patient need despite the best attempts to create regular schedules.

According to survey information collected in the United States as part of the Nurses' Worklife and Health Study (Trinkoff & Storr, 1998), 8.9% of respondents worked in adult critical care areas and 3.5% worked in neonatal or pediatric critical care.

Of the 8.9% adult critical care nurses, 35.9% worked greater than 12 hours per day and 4.7% of these nurses worked over 60 hours per week. In the neonatal and pediatric critical care units, 27.3% of nurses worked greater than 12 hours per day and 5.3% of them worked more than 60 hours per week. These groups worked longer hours per day and per week than other specialized nurses. This, according to Rosa (1995), increases the risk of greater reported fatigue and a decline in work performance. In contrast, only 4.3% of those who worked in the operating room, for example, worked more than 12 hours per day, while those who worked on internal medicine or telemetry or medical-surgical areas reported only 15.9% of the nurses working greater than 12 hours per day (Trinkoff et al., 2006).

The nurses who work in the critical care unit have a relatively constant work load, regardless of whether they work during the day, evening, or night shift. The number of nurses remains relatively constant to ensure a consistent nurse-to-patient ratio as the population is acute and the rapid changes in condition require such consistency. There has been limited research that addresses the impact of shift work upon nurses who work in highly technological environments, such as critical care, where increased patient acuity and rapidly changing patient conditions require increased vigilance and alertness.

Biological rhythms: Human biological rhythms such as body temperature, sleep-wake patterns, and melatonin, cortisol and growth hormone levels fluctuate during a 24-hour period and these are synchronized to the daily rotation or circadian rhythm of the earth (Moore, 1997). These circadian rhythms are generated by a signal from the surprachiasmatic nuclei of the hypothalamus that results in a pronounced oscillation of all physiological and psychological functions over a 24-hour period (Åkerstedt, 2003).

These rhythms are continuously entrained to their surroundings by external synchronizers (zeitgebers) such as light, dark, and social interactions (Rietveld, 1992). When these rhythms are disturbed, as happens with shift work, the body may need to adjust to compensate for this disturbance. Normally, human sleep is consolidated into an average of 6 to 8 hours in a single night, allowing the body to maintain a regular rhythm (Labyak, Lava, Turek, & Zee, 2002). Most individuals display a regular rhythm of sleepiness, with maximum sleepiness occurring when the body temperature is at its lowest. In those who have normal regular sleep, this time of maximum sleepiness is between 3 a.m. and 4 a.m. and again, a minor peak in sleepiness is noted in the early afternoon (Labyak et al., 2002). There is also a period when individuals display maximum wakefulness. This occurs normally in the early evening (Lack, Mercer, & Wright, 1996). Disturbances in the circadian rhythms affect sleep and can cause sleepiness or sleep disruption at inappropriate times (Åkerstedt & Knutsson, 1989). Åkerstedt (2003) suggests that adjustment to night activity may occur in the laboratory, but circadian adjustment to night work is seldom accomplished because of light exposure during the early morning which counteracts the potential adjustment.

Shift work and health: There are a number of health impacts that have been attributed to shift work. Inoue, Kakehashi, Oomori and Koizumi (2004) studied female nurses in Japan and found that those who worked shift exhibited signs similar to those with hypoglycemia, such as tremors, palpitations, and the inability to concentrate during work hours. Mohren et al. (2002) found lack of sleep lowered resistance to infections and during periods of sleep deprivation, respiratory tract infections occur more frequently. They concluded that shift workers may experience more infections compared to day workers (2002). Ruggiero (2003) found that critical care nurses who work permanent night shift are more depressed than those who work permanent day shifts.

In addition, sleep disruptions can lead to unhealthy self care practices such as lack of exercise and poor nutrition. Kivimäki, Kuisma, Virtanen and Elovainio (2001) compared female nurses who had always done shift work with those who had never done shift work and found those who worked shift, particularly over the age of 45 years, had an increased likelihood of smoking and being overweight.

Shift work and rhythms: Shift work rotations often result in disturbances to the circadian rhythms as well as social rhythms and this may also impact the health of the shift worker. Since shift workers often sleep during the day and night, it is important to monitor what the impact of these rhythm changes has upon the critical care nurse. Dingley (1996) reports that shift work has effects on the medical and mental health of the worker. Family and social activities have to be modified, sometimes extensively. Labyak and colleagues (2002) evaluated the relationship of sleep to menstrual function and found for nurses working shift work, that sleep disturbances may lead to menstrual irregularities and a higher incidence of painful menstruation among nurses working nights and rotating shifts.

Shift work and sleep-wake rhythms: When individuals have irregular sleep-wake patterns, sleep disruptions can occur and can lead to chronic sleep deprivation, excessive daytime sleepiness, daytime napping, and subsequent nocturnal insomnia (Labyak et al., 2002). Circadian rhythms favour sleeping at night and therefore, night shift workers often have difficulty staying awake at night (Lee, 1992). They also have difficulty staying awake during the day and their sleep is shorter, lighter, and more fragmented (Dean, Scott & Rogers, 2006). Åkerstedt (2003) suggests that irregular work hours exert strong effects upon sleep and alertness and the effects seem to linger and affect the days off.

Sleep deprivation/disturbance and performance: Many researchers, including Weinger and Ancoli-Israel (2002) have ascertained that sleep deprivation or sleep disturbances can affect performance and may be an important factor in patient safety. More specifically, these researchers reported that patient care may be compromised if a fatigued, sleep-deprived physician is allowed to deal with an unusual or cognitively demanding clinical presentation (2002). Sleep disruptions have been linked, according to Landis (2002), to poor job performance, reduced ability to handle daily stresses, and a higher incidence of drowsy driving. Pilcher and Huffcutt (1996) found that sleep deprivation had a significant negative effect on human functioning, particularly cognitive and motor performance.

Sleep, shift work and critical care nurses: Research exists regarding the effect of shift work on other professional domains, such as astronauts and physician residents and interns (Dijk, et al., 2001; Landrigan et al., 2004; Lockley et al., 2004), but few studies exist related to the sleep-wake patterns of critical care nurses whose practice involves shift work. Trinkoff, Storr and Lipscomb (2001) found that the physical demands for nurses who worked in adult critical care units were higher than all other nurses and that a significant number of these nurses reported getting less sleep than they thought they should. These nurses were also at higher risk for injuries (2001). Dean et al. (2006) suggest that nurses who work in neonatal intensive care units do not obtain enough sleep and were therefore putting their patients at risk for increased errors, as well as having an impact upon the nurses themselves. Ruggerio (2003) found that sleep disturbances and depression are common in critical care nurses but suggests that future study of sleep in critical care nurses should involve objective sleep measurement, such as wrist-worn actigraphy, to study the effects of shift work.

Purpose

The purpose of this study was to seek an understanding of the sleep and wake patterns of critical care nurses who practice within a 12-hour shift work schedule. In order to support the provision of safe patient care and while considering the health of nurses who provide such care, it is important to understand the variables that may affect the care provided. In addition, it is important to determine if there is a correlation between the type of work schedule in which critical care nurses practice, and the effect upon their sleep and wake cycles. Much has been written describing the effect of sleep deprivation upon performance, but there have not been, to this writer's knowledge, studies specifically analyzing the sleep/wake cycle of the critical care nurse population.

In particular, this research sought to describe the sleep-wake patterns of critical care nurses using both the nurses' self reports to obtain a subjective perspective and actigraphy, a well established, non-invasive measure of rest/activity patterns to obtain an objective measure.

Key Components of the Research Study

There were a number of components that were significant to this pilot study. The following definitions were established to provide clarity to the concepts that were explored. These definitions will be explored in further detail in the literature review found in the next chapter.

- *Sleep:* "Sleep is a basic human need" (Lee, 1997, p. 1). "A reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment. Sleep is usually…accompanied by postural recumbency, quiescence, closed eyes and all the other indicators one commonly associates with sleeping" (Carskadon & Dement, 2005, p. 13). The Pittsburgh Sleep Quality Index (PSQI: Buysse, Reynolds, Monk, Berman & Kupfer, 1989) and a daily sleep log will be used to quantify the subjective experience of sleep. Actigraphy will be used as an objective, approximate measure of sleep, specifically reflecting rest and activity patterns.
- *Wake:* According to the Winston Canadian Dictionary (Edwards & Edwards, 2002, p. 729), wake is defined as "to cease to sleep" and "to be aroused, excited, or made awake".
- *Shift work:* Shift work is defined by the National Sleep Foundation (2005) as a work schedule that falls outside the typical '9 to 5' business day.
- *Sleepiness:* The tendency to fall asleep will be measured by the Epworth Sleepiness Scale (ESS: Johns, 1991).

- *Sleep deprivation:* Sleep deprivation can result from self-imposed sleep restriction, lifestyle or work demands that require staying awake at night, or traveling across time zones (Lee et al., 2004; Vitaterna et al., 2001). The physiological effects of sleep deprivation include neurological changes, such as impaired memory capacity, where there is no reserve to compensate for the decrease in sleep and the ability to retain new information is diminished (Rollinson et al., 2003).
- *Sleep hygiene:* The environmental and lifestyle practices that influence sleep such as ingesting caffeine, exercising, napping, bedtime routines, and consistent bedtimes all affect ones' sleep (Cheek, Shaver, & Lentz, 2004). Sleep hygiene practices will be assessed using a sleep log and the Sleep Timing Questionnaire (Monk et al., 2003).
- *Critical care nurse:* Critical care nurses are nurses who provide "the bulk of the care to patients with oftentimes unstable conditions and must therefore be alert to subtle changes in patients' conditions, perform accurate clinical assessments, and respond in an expedient manner" (Scott et al., 2006).

Study Assumptions

There are a number of assumptions that are made throughout this study.

1. The number of patients within the Intensive Care Units will fluctuate continuously.
2. The acuity of patients will vary from day to day and minute to minute.

3. The nurse-to-patient ratio will vary depending on staffing volumes and patient acuity.

4. The hours of work may change due to staffing volumes, illness, or patient acuity.

5. The nurses' sleep may be disrupted because of events that may have occurred during the previous shift (e.g. death of patient, altered family dynamics, ethical dilemmas, or stress related to all or any of these).

6. Many of the nurses participating in the study will have responsibilities that will alter their sleep plans and patterns.

7. Nurses have developed sleep and wake strategies to cope with the effects of shift work.

8. Nurses who are not working on the weekend will have to alter their sleep patterns to accommodate the activities of those around them.

9. Sleep patterns on weekends are different from those during the weekday.

Conceptual Framework

A conceptual model or framework was chosen to try to understand and describe the relationships between the ideas that will be explored during this research project, and to help to map the research process. According to Fawcett (2001), a conceptual model is made up of "abstract and general ideas or concepts and propositions that address the phenomena of central interest to a discipline" (p. 339). Concepts represent some aspect of reality that can be quantified, (Marriner-Tomey, 1994) and therefore, it is helpful to utilize a conceptual model to plan how the research is conducted and to quantify results of the information gathered.

The Symptom Management Model

The Symptom Management Model (Dodd et al., 2001; Larson et al., 1994) is a useful framework when considering a subjective experience that reflects changes in biopsychosocial functioning or cognition of an individual. These symptoms are important cues that allow problems to be recognized and strategies to be developed to help to alleviate the symptoms. The subjective nature of the symptoms can lead to various definitions, interpretations, and perceptions. However, perception or lack of perception of a symptom does not imply that an individual is experiencing optimal health and well-being or that a symptom does not exist. The Symptom Management Model, which will be outlined in greater detail in the literature review, was selected for this study to provide an organized framework to develop an understanding of the sleep-wake patterns of critical care nurses.

Study Questions

The following questions were explored in this research study:

1. How do the sleep/wake patterns of critical care nurses who are engaged in shift work compare with normative adult sleep/wake patterns?
2. What is the self-reported experience of sleep/wake patterns for critical care nurses engaged in shift work?

   a) Is there a difference in sleep/wake patterns between work and non-work days?
3. What are the rest/activity patterns of critical care nurses engaged in shift work as measured by actigraphy?

a) Is there a difference in rest/activity patterns between work and non-work days?

4. How do the nurses' subjective reports of sleep/wake patterns compare with their objective measures of rest/activity?

Significance of the Study

Irregular work hours appear to exert strong effects on the sleep and wake patterns of shift workers. More than just the circadian rhythms are affected; all aspects of the individuals' life, including the days off, appear to be disrupted by sleep disturbances. The alterations in sleep patterns may be responsible for considerable human and economic costs related to fatigue induced accidents and impairment. Ruggiero (2003), studied critical care nurses in the United States and found that sleep disturbances and depression are common in critical care nurses particularly among nurses who worked nights (p. 343-344). She suggests that nurses who suffer from fatigue, depression, and sleep problems may not perform to their optimum, affecting patient care and the overall critical care work environment.

Despite the vast amount of research and literature that discusses the effects of sleep disturbance on performance, health, and safety among those who work shift, no study was found that specifically, objectively measured the sleep-wake patterns of critical care nurses. It is important to provide both objective and subjective measurements of the sleep patterns of this group of highly skilled, yet vulnerable nurses in order to understand the factors that potentially affect their health and that of the acutely ill patient population cared for by them.

Chapter 2

Literature Review

The purpose of this chapter is to provide an overview of the literature related to sleep, sleep deprivation, and the impact of shift work on women, nurses, and critical care nurses specifically. This review of the literature begins with an overview of the concept of sleep, from a physiologic perspective. The benefits of sleep, the role of the circadian rhythms, and the effects of sleep deprivation are presented. Research will be reviewed that looks at the effect of shift work upon nurses and the effect of shift work upon sleep/wake pattern. Sleep deprivation will be viewed within the context of effects upon performance and health and upon nurses, particularly those who work in critical care areas.

Sleep: An Overview

Sleep has been described by Carskadon and Dement (2005), as "a reversible behavioral state of perceptual disengagement" (p. 13) accompanied by "postural recumbency, quiescence, closed eyes" (p. 13). Sleep restores most body systems, with positive effects on growth, healing, the immune function, and metabolic activities (Redeker, Ruggiero, & Hedges, 2004). It is a basic human need that is often taken for granted. Many people see sleep as an option, rather than a requirement. Healthy adults spend one third of their life asleep, and only think about sleep when it is inadequate. Sleep alternates between a period of diminished response to external stimuli and wakefulness on a daily basis (Lee, 1997).

There are two separate sleep states, non-rapid eye movement (NREM) and rapid eye movement (REM) sleep. New nomenclature depicts Stage W as representing the waking state that ranges from full alertness through the early stages of drowsiness. This is followed by NREM sleep which is divided into a number of stages (Iber, Ancoli-Israel, Chesson & Quan, 2007). Stage N1, formerly known as Stage 1, is the stage of lowest arousal threshold where one can be easily awakened and represents the transition from wakefulness to sleep (Iber, et al., 2007). This is the stage where a person feels drowsy. Stage N2 (previously Stage 2) is characterized by a further reduction is heart rate, one or more trains of sleep spindles or bursts of electrical brain wave activity, and one or more large electrical depolarizations known as K complexes. Stage N3 has the highest arousal threshold and it is more difficult to awaken during these stages. This stage had previously been referred to as Stage 3 and Stage 4 sleep, and is characterized by an absence of eye movements and slow wave sleep (Iber et al., 2007). It is during Stage N3 that the body maximizes repair and restoration by growth hormone secretion and the stages at which the heart rate, blood pressure, and temperature are reduced. In NREM, muscle tone is moderately high, body movement is common, and the brain has short bursts of activity (Siegal, 2001).

During Stage R (REM) sleep, most muscles of the body are atonic, adopting a paralyzed-like protective state, with the exception of respiratory, genital, and eye muscles, the latter moving rapidly in short bursts. This is the stage that appears to be necessary for stimulation of a part of the brain used in some types of learning and is mostly associated with dreaming (Iber et al., 2007; Siegal, 2001). REM sleep predominates the second half of the night in normal sleep. It is during this stage that the individual experiences an increase in metabolic processes (Siegal, 2001). The components of REM sleep are most clearly seen by recording electrical activity from the brain with an electro-encephalograph (EEG).

The patterns recorded on the EEG are very distinct and help to distinguish the sleep stages from each other. Alpha waves appear when the eyes are closed. During the sleep onset period, alpha waves give way to some theta waves and this change signals the onset of NREM Stage N1 sleep. This stage typically accounts for less than 5-10% of sleep. Sleep spindles and K complexes indicate the onset of Stage N2 sleep. Almost 50% of the night is spent in Stage N2. As the brain waves begin to slow, delta waves signal the beginning of deep sleep. These slow waves are seen in Stage N3 and this is where 20% of sleep is spent. This is believed to be the restorative sleep believed to be necessary for a body to function. The EEG waves of REM sleep are similar to those exhibited in an awake state. Here bursts of eye movement and twitching of facial muscles can be seen. The brain is very active, but the body appears rigid. People denied REM sleep complain of hypothalamic-related symptoms such as an increase in appetite, anxiety, irritability, and difficulty concentrating and coping with stress (Lee, 1997). As well, physiological changes such as irregular pulse and respirations, increased oxygen consumption, increased cerebral blood flow, increased blood pressure, loss of facial muscle tone, and absent spinal reflexes are noted during REM sleep (Zeman & Reading, 2005). Eye movements can be recorded with electro-oculography (EOG) and muscle activity is recorded using electromyelography (EMG).

One full sleep cycle includes NREM and REM sleep. The cycle repeats four or five times during the night and ranges from 60 minutes during the early part of the night to 120 minutes toward the end of night sleep (Carskadon & Dement, 2005). It has been suggested, however, that shift workers get a total of 2-4 hours less sleep every 24 hours (Lamond et al., 2003).

Circadian Rhythm

Human sleep is regulated by a timekeeping system known as the "circadian rhythm" or biological clock. This clock allows humans "to anticipate and prepare for changes in the physical environment that are associated with day and night" (Vitaterna, Takahashi, & Turek, 2001, p. 85) ensuring that the correct task is completed at the correct time of day or night. The biological clock also provides internal temporal organization and ensures that internal changes take place in a coordinated manner (Vitaterna et al., 2001). These circadian cycles seem to continue through a period of close to, but not exactly 24 hours and appear to be synchronized with the rotation of the earth (Pronitis-Ruotolo, 2001). They are also synchronized by external time cues, known as zeitgebers, such as the light-dark cycle, outside temperature, mealtimes, and social cues. If there are shifts in the external cues, the rhythms will readjust to match. Although the light-dark cycle is the major cue, other factors, such as social interactions, activity or exercise, and temperature can modulate a cycle's phase (Vitaterna et al., 2001). Interestingly, temperature in particular, can affect the phase of a cycle, but will not alter the rate of the cycling. Therefore, a cycle may start earlier or later than normal, but will last for the same length of time.

It is believed that this biological clock resides in the suprachiasmatic nuclei of the hypothalamus near the base of the brain (Klien, Morre, & Reppert, 1991). The surprachiasmatic nucleus of the hypothalamus "exerts gentle control over the sleep-wake cycle" (Beersma & Gordijn, 2007, p. 1), which allows for napping during the day or staying awake at night. Signals are generated from the retina of the eye to the hypothalamus in regular 24-hour oscillations for nearly all physiological and psychological functions. The time of day affects the level of a person's metabolism and alertness with maximum levels of sleepiness between 2:00-5:00 a.m. and maximum alertness between noon and 8:00 p.m. (Blachowicz & Letizia, 2006). Henning et al. (1998) demonstrated that there appears to be a regular circadian variation in cortisol levels under normal circumstances, where cortisol levels decrease between 11 p.m. and midnight and increase sharply at 6:00 a.m. Melatonin levels reach a maximum level at 4:00 a.m. in the morning and a minimum level at 4:00 p.m. in the afternoon, according to Äkerstedt (2003). Melatonin is the hormone that is produced at night to decrease wakefulness and encourage sleep. Sleep is a homeostatic process that interacts with circadian processes that control our sleep/wake cycle (Weininger & Ancoli-Israel, 2002). The circadian pacemaker is not normally able to adjust to rapid alterations in the sleep-wake pattern (Revell & Eastman, 2005). Hormones such as noradrenaline, prolactin, and growth hormone are dependent on sleep for their circadian rhythmicity and lose their periodic pattern of excretion during sleep deprivation (Bonnet, 2005). When the sleep-wake cycle is out of synchrony with the circadian clock, adverse effects may result. For those who work shift work, physical zeitgebers, such as daylight-darkness cues, are opposed to regular nocturnal alignment and social cues, such as mealtimes and day oriented activities (Hughes & Stone, 2004; Monk, 2005). Therefore, the asymmetry of working when most individuals are sleeping, and sleeping when most individuals are awake impacts the sleep of shift workers. Late evening and night shift workers must be awake and alert when the body is prompted to be asleep (Blachowicz & Letizia, 2006).

They are required to realign their circadian pacemakers in order to participate in the environment that surrounds them. Individual differences such as habitual sleep need, preference for late nights versus early mornings, and health factors all influence how well individuals tolerate circadian alterations (Monk, 2005).

Sleep Deprivation

Sleep can be disrupted for a variety of reasons. Healthy individuals who have experienced disrupted sleep often complain of symptoms such as fatigue, irritability, problems concentrating, and changes in their personality. Hakkionen, Alloui, Gross, Eschallier and Dubray (2001) found that disturbed sleep can decrease one's pain tolerance levels. Short term memory loss, apathy, poor communication skills, stress, depression, illness, drug dependency, nocturia, pain, anxiety, and changes in diet or exercise are among the symptoms described by those who have experienced sleep disruption. Some may notice changes in their reaction time and attention span, their ability to co-ordinate their psychomotor functioning, and to make appropriate decisions. The reasons for sleep disruption are numerous and among the contributors are gender (Ruggiero, 2003), the provision of child care (Ruggiero, 2003; Trinkoff, Geiger-Brown, Brady, Lipscomb & Muntaner, 2006), a snoring or restless bed partner, lack of social support, and shift work (Lee, 1997; Ruggiero, 2003; Stokowski, 2004).

Sleep deprivation can result from self-imposed sleep restriction, or sleep restriction imposed by lifestyle or work demands that require staying awake at night, or traveling across time zones (Lee et al., 2004; Vitaterna et al., 2001). How one responds to sleep loss is dependent "on the prior sleep amount and distribution" (Bonnet, 2005), as well as individual characteristics such as age and personality. It is also dependent on the length of time one is awake and is interdependent on the circadian rhythms. The homeostatic mechanism, viewed as a biologic pressure to sleep, or sleep load, increases during a person's wakeful hours. As time without sleep increases, the need to sleep also increases. With sleep, the pressure or need to sleep decreases, but chronic sleep loss results in an accumulation of sleep debt and progressive tiredness is noted by the individual suffering from sleep deprivation (Blachowicz & Letizia, 2006).

According to Bonnet (2005), in the early stages of sleep deprivation, there are several measures that can reverse the effects of sleep loss. Activity, bright light, noise, temperature, posture, stress, and drugs have all been shown to influence the detrimental behavioral effects of sleep deprivation (Bonnet, 2005). The physiological effects of sleep deprivation include neurological changes, such as impaired memory capacity, where there is no reserve to compensate for the decrease in sleep and the ability to retain new information is diminished (Rollinson et al., 2003). Total sleep deprivation results in performance loss on tasks such as reaction time, short term memory and additions, and increased daytime somnolence (Bonnet, 1985). Drummond and colleagues suggest that the brain recruits additional cognitive resources to compensate for sleep deprivation in order to complete required tasks (Drummond, Gillin, & Brown, 2001).

Sleep deprivation is also associated with autonomic and biochemical changes such as alterations in the normal diurnal rhythm of both blood pressure and urinary catecholamine excretion (Yamasaki, Schwartz, Gerber, Warren, & Pickering, 1998). Aldosterone is a hormone that plays a key role in homeostatic regulation of the electrolyte balance and extracellular compartment volume. It is secreted in an episodic 24-hour pattern, with an increase in plasma levels noted during the night and early morning hours. Charloux and colleagues found that the aldosterone levels were lower during sleep deprivation than during sleep. The implication of this is an increase in nocturnal natiuresis, or the need to wake to void at night (Charloux et al., 2001). Depressed immune function and an increased susceptibility to infections have also been demonstrated with sleep deprivation (Kobayashi, Furui, Akamatsu, Watanabe, & Horibe, 1997) resulting in increased susceptibility to common infections such as the common cold, flu-like illness, and gastroenteritis (Mohren et al., 2002). Bonnet (2005) suggests that the drive to sleep is a physiological imperative that is as strong as the drive to breathe, and that sleep deprivation may be an unrecognized public health problem that impacts the behavioral and physiological aspects of health.

Sleepiness

Sleepiness is a state of physiologic need, and its intensity is evidenced by how rapidly sleep onset occurs, how easily sleep is disrupted, and how long sleep lasts. In otherwise healthy adults, a number of factors can cause sleepiness such as, reduced, disrupted or fragmented sleep time. Sleepiness has a normal circadian rhythm, and it is increased in circadian rhythm misalignments such as those that can occur in shift work. (Roehrs, Carskadon, Dement, & Roth, 2005). Sleep deprivation or restriction of sleep increases sleepiness and sleep reverses it. There are a number of subjective and behavioral indicators of sleep, such as yawning, eye rubbing, and head nodding. These can be reduced if one is highly motivated to stay awake, during conditions of excitement, exercise, or activity. For example, sitting, as opposed to lying in bed will increase the mean sleep latency time (MSLT) by six minutes (Bonnet & Arand, 2005). However, when the symptoms of sleepiness are severe or persistent, it becomes increasingly more difficult to reduce the impact on overt behavior (Roehrs et al., 2005).

In the typical 24-hour sleep and wake schedule, maximum sleepiness occurs in the middle of the night when the individual is sleeping, therefore it goes essentially unnoticed. However, when one is forced to be awake in the middle of the night, or sleepiness intrudes on one's usual waking activities during the day, symptoms of sleepiness, such as loss of energy, weariness, difficulty concentrating, and memory lapses are experienced (Roehrs et al., 2005).

Shift Work and Sleep Deprivation

Three out of 10 employed Canadians worked some type of shift in 2000-2001 (Shields, 2002). Shift work is more common in some occupations, such as blue-collar or sales, emergency, and other service industries (Parkes, 1999; Shields, 2002). The many adverse effects of shift work on sleep, physical and mental health, job performance, and psychosocial well being have been well documented (Edell-Gustafsson, Kritz, & Bogren, 2002; Fitzpatrick, While, & Roberts, 1999; Marquié & Foret, 1999; Ruggiero, 2003). As observed by Harrington, though there are many studies related to shift work, many rely on a self selected population, and those workers who continue to remain as shift workers for years, are often a survivor population (2001). A major factor in the disruptive influence of shift work, according to Smith and colleagues, results from a mismatch between humans' circadian rhythms, which are programmed to make individuals day–active, and environmental time cues. As a result, people who work shift are required to be active when their bodies are preparing them for sleep and inactivity, and to sleep when their body clocks are preparing them to be active and awake (Smith et al., 1999).

Disruption in circadian rhythm as a result of shift work can lead to a number of physiologic changes. The body temperature is normally regulated to decrease during the nighttime when activity is generally less and increase during the day when there is a need for alertness and physical performance. However, for shift workers, body temperature is lowest when the person is required to be most active. During the day, temperature is highest when the shift worker is trying to sleep. In addition, gastric activity, intestinal enzyme secretions, cardiovascular effects, and hormonal changes are noted with circadian rhythm disruption (Blachowicz & Letizia, 2006; Harrington, 2001; Poissonnet & Vernon, 2000; Tenkanen, Sjoblom, Kalimo, Alikoski, & Harma, 1997).

There are also many social disruptions experienced by those who are shift workers. Often, many family or social activities are oriented around the day and the rhythms of the general population. Isolation from community and religious activities and from day-working friends make social and political associations difficult (Monk, 2005). Saturday and Sunday work, according to Harrington (2001), can preclude involvement in sporting events or religious activities. Working during the evening shift makes spending time with children complex. In fact, according to Monk (2005), the shift worker may only see children when they are asleep in bed. If the shift worker chooses to partake in these activities, it is usually at the expense of sleep. If they do not, they risk social marginalization. Monk (2005) studied male shift workers and suggests that the role of sexual partner, social companion, and protector-caregiver are compromised because of shift work. According to Clissold, Smith, Accutt and Di Milia (2002), nurses experience more fatigue when shift work is combined attempting to accommodate partners and even more fatigue was noted when the parental role was added to the partner role (2002).

These concerns, as well as housework, shopping, and leaving a partner alone at night can all lead to marital strain and family dysfunction (Harrington, 2001).

Excessive sleepiness from extended periods of sleep loss over time, puts individuals at increased risk for injury, accidents and errors, at work or outside of work (Lee & Lipscomb, 2003). The disruption in circadian rhythms combined with sleep deficit and fatigue can lead to performance being impaired, particularly in the early morning hours (Harrington, 2001). By far, the greatest negative effect of shift work is sleep loss. The effects are most noticeable after night shift where the quantity of sleep may be reduced by up to two hours a day and the quality is also impaired. REM sleep and Stage 2 sleep, where half the night's sleep is spent, are often reduced in shift workers (Harrington, 2001). Shift workers who are denied the opportunity to sleep when the circadian rhythms are disrupted are prone to complaints of fatigue and somnolence. The two worst sleeping problems reported by shift workers in a European study were difficulty falling asleep, and waking up too early (Marquié & Foret, 1999). In addition, workers who have shortened recovery times between shifts have an increased sleep debt (Axelsson, Åkerstedt, Kecklund, & Lowden, 2004).

Shift Work and Female Nurses' Health

Almost half of the shift workers in Canada are women and half of these people are employed in the service industries. According to the 2005 Canadian Institute for Health Information Statistics, 251,675 people in Canada were registered nurses and of these, 94.4% were women. Several studies have identified differences in the effects of shift work on females (Coffey, Skipper, & Jung, 1988; Edell-Gustafsson et al., 2002; Gold et al., 1992; Lee, 1992; Lee & Lipscomb, 2003). The majority studied women in regular shift systems. Some of these studies were conducted using female nurses as subjects, who worked either rotating or night shift. Few studies examined sleep in shift combinations typical of irregular shift systems (Sallinen et al., 2003). Those that do exist are generally self-reports, surveys, and questionnaires (Demerouti, Geurts, Bakker, & Euwema, 2004; Sveinsdóttir, 2006; Trinkoff et al., 2006).

There are a number of reasons that women choose shift work. They often state family characteristics as a main reason for working shift, whereas men's reasons are unrelated to the family (Wilson, 2002). Throughout the lifespan, shift work appears to affect female workers more than males. A 1999 European study found female shift workers, by the age of 42, exhibited more frequent difficulty falling asleep than their male counterparts (Marquié & Foret, 1999). Similar gender differences were found in the Work-Sleep Survey of almost 3,000 American shift workers (Tepas, Duchon, & Gersten, 1993), where female night workers reported significantly shorter sleep periods than male night workers of the same age. Some of these differences may be due to domestic obligations of women. Child care responsibilities and maintaining the home may interfere with sleep and may decrease the amount of available sleep time. Some women appear to experience more difficulty in adjusting to shift work than others, reporting higher levels of fatigue, sleep disturbances, stress, and gastrointestinal upset (Lee, 1992). In a classic study by Folkard, Monk and Lobban (1978), full-time and part-time nurses who worked permanent nights were compared and it was found that 36% of the full-time nurses had children living with them at home, compared to 96% of the part-time nurses. It was suggested that the full-time nurses were able to make more of a commitment to night work than those who worked part-time because they were more able to sleep later in the morning, take afternoon naps before their shift, and sleep between two shifts.

Those who work rotating shifts have been shown to have numerous health problems. For example, women working a rotating night shift at least three nights per month for 15 or more years may have an increased risk of colorectal cancer (Schernhammer et al., 2003) and those who work for 30 or more years on rotating night shifts have a higher risk of breast cancer than those who never worked rotating shifts (Schernhammer et al., 2001). Trinkoff et al. (2006) in their study of nurses, state that "increased hours in a work environment with high physical and psychosocial demands can adversely affect nurses' health" (p. 61). If nurses do not have sufficient rest and recovery time, they become chronically exhausted and this leads to a physiologic depletion or exhaustion that continues into the next work day (Rosa, 1995).

Night shift workers also have increased appetite, constipation, and problems with digestion. Dracup and Bryan-Brown (2000) suggest that this may be in part, due to meal schedules that are usually opposite normal intestinal enzymes and hormonal secretion. Digestive enzymes are secreted in cyclical fashion and alternating patterns of eating while rotating from night to day shift may offset this pattern and may be in disharmony with the body's normal cycle (Muecke, 2005). Obesity, cardiovascular disease, peptic ulcers, indigestion, dyspepsia, nausea, diarrhea, abdominal pain, and constipation are reportedly experienced by shift workers (Harrington, 2001; Learhart, 2000; Murata, Yano, & Shinozaki, 1999; Perkins, 2001). It has been suggested that obesity may be higher in those who sleep less and this may be due to levels of the hormones leptin and ghrelin. Leptin levels, released by fat cells, signal the brain to stop eating and ghrelin, a peptide that is produced in the stomach signals to continue eating. Those who are sleep deprived have lower levels of leptin, the satiety or "stop eating" hormone, and higher levels of ghrelin (Schardt, 2005). In addition, a drop in leptin may be interpreted by the body as a signal that the body is starving and responds by burning fewer calories. The insulin resistance syndrome may also be stimulated by sleep deprivation. As a result, the levels of HDL cholesterol are low, while blood pressure, triglycerides, and blood sugar are high. Insulin resistance syndrome in turn, increases the risk of heart attack, stroke, and diabetes (Spiegel, Tasali, Penev, & Van Cauter, 2004). High cholesterol is more frequent among night shift workers who have greater than 10 years experience (Portela, Rotenberg, & Waissmann, 2004). In addition, caffeine may be consumed in an effort to combat sleepiness and this may enhance gastrointestinal irritation (Dracup & Bryan-Brown, 2000). According to Touitou et al. (1990) irregular work schedules interfere with the circadian regulation of hormone concentrations such as cortisol, which is important in regulating the stress response, prolactin, and melatonin.

In a descriptive study by Labyak et al. (2002), a relationship between sleep disturbances and changes in menstrual function was identified in female shift workers. They found that these women noted more sleep disturbances, feelings of general malaise, and difficulty concentrating at work compared to those who did not report changes in menstrual function. Labyak et al. concluded that the 24-hour clock plays a role in regulating the production, release, synthesis, and action of reproductive hormones and the timing is critical to the ovarian cycle. There researchers suggest changes in menstrual function may be a marker for shift work intolerance. Further, shift workers who are pregnant may be at higher risk for premature labor and low birth weight infants (Zhu, Hjollund, & Olsen, 2004). Others have also found that circadian disruption may lead to headache, irritability, anxiety, and depression among shift workers (Rose, Ware, Kolm, & Risser, 2000)

The impact of shift work on job related stress was studied by Coffey et al. (1988). Participants were asked to rate their knowledge and technical skills, the nature of direct patient care, interpersonal conflicts, physical working conditions, and management of the unit. The nurses who worked a rotating shift experienced significantly more job-related stress than those who worked at other times of the day.

The combination of shift work, mental and cognitive demands, and responsibilities among nurses can increase cognitive anxiety, chronic fatigue, and emotional exhaustion (Edell-Gustafsson et al., 2002). Those who work night shifts experience more fatigue, sleep disturbances, and anxiety and depression, and have poorer sleep quality than those who do not work night shift (Gold et al., 1992; Lee, 1992). Nurses who work the night shift are at higher risk for changes in brain function than those who maintain normal daytime work schedules according to Dracup and Bryan-Brown (2000). Night shift workers or those who rapidly rotate shifts have difficulty in adjusting their internal clocks and often experience insomnia, sleepiness, malaise, and mood disorders (Knauth & Härmä, 1992). In a qualitative study by Novak (1996), nurses who worked nights identified that sleeping during the day was more difficult than sleeping during the night because of external noise during the day rather than because of the excessive light. According to Lee (1997), night nurses reported struggling to stay awake almost 16% more than those who worked day or evening shift. They also report more sleep disturbances which, they explain were related to child care responsibilities (Lee, 1997). Often nurses who work night shift are younger and less experienced than day shift workers (Gold et al., 1992; Lee, 1997). Similar to findings of others (Coffey et al., 1988; Poissonnet & Veron, 2000), Edell-Gustafsson et al. (2002) noted that mental tiredness, exhaustion, cognitive stress, anxiousness, and altered mood were common among women who had insufficient sleep.

Sleep Deprivation and Performance

There is an increasing awareness of the effects of sleep deprivation on performance. The issue has received heightened awareness as patient safety has become a priority for government and healthcare agencies. Many of the studies have been conducted on physicians, medical residents and interns (Papp et al., 2004; Rollinson et al., 2003; Weinger & Ancoli-Israel, 2002). Some studies have been conducted on astronauts during space shuttle missions (Dijk et al., 2001), drivers (Philip et al., 2004), nuclear power company workers (Smith, Tanigwawa et al., 2005; Smith et al., 1999), and military police (Demerouti et al., 2004). Few have studied the effect of sleep deprivation and performance on nurses.

Sleep deprivation can lead to a decrease in alertness and vigilance. In a study by Papp and colleagues (2004), 149 medical residents completed a quantitative questionnaire, the Epworth Sleepiness Scale (Johns, 1991), to assess sleepiness and workplace sleep attitudes. They found that residents reported adverse effects on their ability to learn, in short-term and long-term acquisition of material. They reported having less patience with patients' families, increased risk of making mistakes, inefficiency, and falling asleep on the job. In addition, they reported a decrease in fine motor skills.

Performance may be affected by sleep deprivation. A study by Philip et al. (2004) directly measured reaction time in young and older drivers. Subjects were given a task that required them to respond quickly to a stimulus. They were asked to rate their reaction time and level of sleepiness prior to completing the task. Their actual sleep and wake duration was monitored by actigraph and they rated their sleepiness on the Karolinska Sleepiness Scale (Åkerstedt & Gillberg, 1990). The reaction time of young drivers was better than older ones, but sleep deprivation affected young drivers more than older drivers. The younger subjects reported more fatigue, but also overestimated their performance (Philip et al., 2004). Similar findings were reported in a study in which 15 subjects were to perform a psychomotor vigilance test during the night shift (Dorrian et al., 2003). Subjects were asked to rate their alertness and performance speed and accuracy before and after each test. Their performance levels declined significantly, as did their level of alertness, but their ability to self-monitor their performance was only moderately accurate. This is significant in that many nurses who work shift are younger and less experienced. They may lack the ability to judge their level of impairment which in turn could adversely affect patient safety.

A meta-analysis conducted by Pilcher and Huffcutt (1996), demonstrated that cognitive performance was more affected by sleep deprivation than motor performance and that mood was much more affected than either cognitive or motor performance. Sleep deprived subjects performed significantly worse on motor tasks than non-sleep deprived subjects (Pilcher & Huffcutt, 1996). Increase in attention lapse is also reported. The brain slows and the pressure to complete tasks increases the risk of error, working memory declines, performance quality decreases as the shift progresses, activities that are judged to be non-essential are neglected. There is an increase in involuntary periods of micro sleep. In one study, nurses who worked the night shift reported "nodding off" while on shift, at least once per week, while those who worked days, evenings or rotating shift did not (Gold et al., 1992). Coffey et al. (1988) found a significant relationship between overall performance and shift. Performance was much lower on night shift according to the self-reported study. Unfortunately, the actual performance levels were not measured. In addition, there is no mention of the number of shifts worked and whether this would impact one's self-reported performance measurement.

There is a tendency for sleep deprived individuals to alter their behavior in order to remain effective. Engle-Friedman and colleagues (2003) studied 50 undergraduate students following one night of no sleep loss and one night of sleep loss. The students were asked to perform the Math Effort Task, where addition problems were presented on a computer. Participants were able to select from five levels of difficulty. When students were subjected to sleep loss, they selected less difficult problems and were able to solve these correctly. However, the sleep deprived group did not perceive that they had chosen less difficult problems to solve, indicating that they were unaware of a reduction in effort on their part.

Risks, errors, accidents and crashes increase with sleep deprivation. Six hundred and thirty five Massachusetts nurses were surveyed to examine the relationship between shift work and injuries and errors. It was found that those individuals who worked a rotating shift had twice the risk of nodding off while driving to or from work and twice the risk of accident or error related to sleepiness (Gold et al., 1992). When this study was analyzed by Lee and Lipscomb (2003), they found that nurses working permanent night shift or rotating shifts were at high risk of injury to themselves or their patients because of sleepiness. Novak and Auvil-Novak (1996) found that nurses stated that there was no effect on performance while on the job; however, when questioned further, 95.5% of these nurses reported that they were involved in at least one near-accident or accident during the last year. The near accidents included falling asleep at the wheel, running off the road, missing exits, or falling asleep at traffic signals.

Sleep Deprivation and Critical Care Nurses

Critical care nurses care for patients who require continuous assessment, intervention, and vigilance, regardless of time of day or night. Dracup and Bryan-Brown suggest that "one of the most defining aspects of critical care is its unremitting, 24-hours-per-day, 7-days-per-week nature" (2000, p. 224). This need for 24-hour monitoring and intensive care requires critical care nurses to work a variety of shifts. The consequences related to sleep deprivation, such as diminished performance, cognitive and psychomotor impairment, and increased risk of error and accident have been studied in a variety of industrial, laboratory and non-healthcare related settings. In 2005, highly skilled critical care nurses constituted 7.2% of Canada's 254,752 nurses, according to the Canadian Institute of Health Information. Yet, despite the relatively large population, nurses in general, and critical care nurses, specifically, have largely been overlooked in the literature related to the effect of shift work on the quality and quantity of sleep experienced by this group.

Scott, Rogers, Hwang and Zhang (2006) surveyed over 500 critical care nurses and found that the longer the work duration, the more likely the chance of errors and near errors among nurses. In spite of the fact that this study utilized self-reports and subjective measurement strategies, they found that critical care nurses who worked more than 12.5 consecutive hours, despite the activities within the ICU and the frequent interactions with other health care providers, were more likely to struggle to stay awake at work, than those who worked fewer hours. The risk of falling asleep at work was much greater when the shifts were longer than 8 hours in length and even more so when the shift was longer than 12 consecutive hours. Critical care nurses' ability to remain vigilant decreased significantly as their length of shift increased (Scott et al., 2006). An older study by Todd, Reid and Robinson (1989) found that nurses who worked 8-hour shifts had better scores on nursing performance tests than those working 12-hour shifts. A number of studies found that nurses who worked 12-hour rotating shifts were less safe and productive during the third to fourth day of a series of day shifts, had difficulty staying awake, and were more likely to be involved in accidents after leaving their shifts (Budnick, Lerman, Baker, Jones, & Czeisler, 1994; Gold, et al., 1992; Smith, Folkard, Tucker, & Macdonald, 1998).

Despite the fact that sleep deprivation is not unique and the problems associated with it can be devastating, it is surprising that very little information exists about the effects of sleep deprivation and its effects on critical care nurses. Nurses and physicians who work in hospital are among the few professions who experience sleep deprivation as a side effect of their career choice (Dracup, & Bryan-Brown, 2000). It has been shown that long shifts and round the clock schedules lead to an inability to concentrate, poor decision making, and higher risk to the patient related to their mortality and morbidity. Nurses who work in the ICU setting provide increasingly complex care to increasingly sicker patients. They are required to be extra vigilant and be able to respond quickly to any subtle changes in the patient's condition. Critical care nurses, regardless of time of day or night must prepare patients for and assist physicians during procedures, deal with visitors, family, physician consultations, and changing treatment orders and intervene when appropriate. In spite of the increased demands upon this specialty of nursing, few studies have sought to address one of the fundamental quality of life indicators – sleep.

One of the few studies to address the issue of shift-related differences in chronic fatigue and the contributions of sleep quality, anxiety, and depression was conducted by Ruggiero in 2003. In her study, 142 female critical care nurses were surveyed. Chronic shift worker fatigue was measured with the Standard Shift work Index Chronic Fatigue Scale (Barton et al., 1995). The quality of sleep was measured with the Pittsburgh Sleep Quality Index (Buysse, et al., 1989) and depression was measured with the Beck Depression Inventory II (Beck, Steer, & Brown, 1996). Overall, critical care nurses who worked both day and night shift reported poorer sleep quality than did non shift workers, but nurses who worked only night shift reported poorer quality sleep and higher levels of depression than those who worked day shift. The study suggests that critical care nurses who work night shift are more depressed than those who work day shift (Ruggiero, 2003). There do not appear to be any studies, however, that specifically address the issue of sleep deprivation in the context of shift work, and its effects on critical care nurses.

In summary, there have been numerous studies that have researched sleep, circadian rhythms, sleep deprivation and the effects of lack of sleep, both on the person who is sleep deprived and on those around them. Research has been conducted to study the effects of shift work upon the worker including the effect upon their performance and upon their health. The research has looked at the effect of shift work on nursing and females in particular. However, there are very few studies that have clearly described the sleep/wake patterns of nurses, and none, to this researcher's knowledge that has described the sleep/wake patterns of critical care nurses who work shift. It is the intent of this research study to address this apparent gap in the literature.

Chapter 3

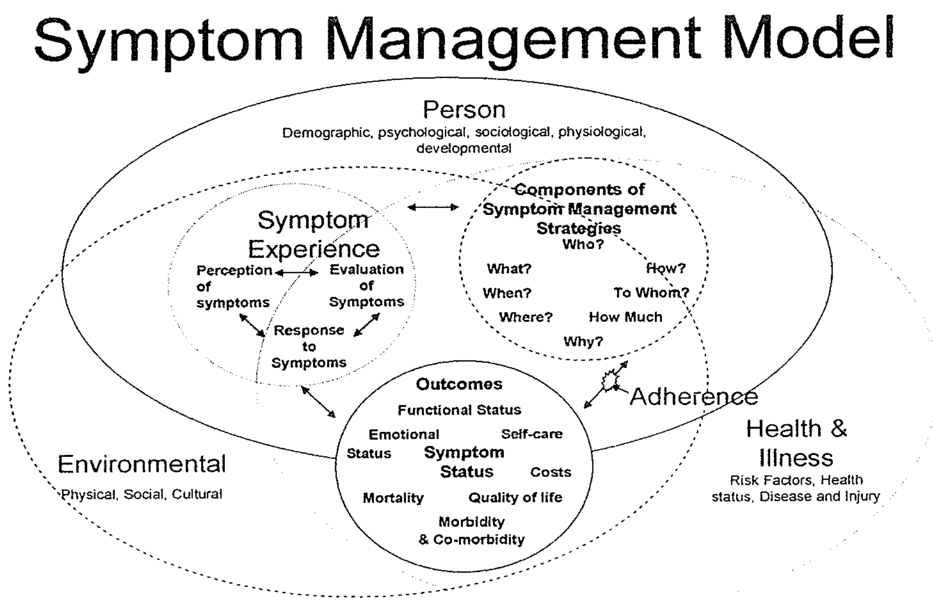
Conceptual Framework

The purpose of this chapter is to present an overview of the Revised Symptom Management Model (Dodd et al., 2001). The Symptom Management Model will be described and the dynamic nature of the model will be addressed. An overview of the domains of nursing science, the symptom experience, symptom management, and outcomes will be briefly outlined. The relevance of this model and its application to this study will be identified. The many factors within the domains of nursing science will be carefully considered and the mechanisms that will be utilized to illustrate the symptom experience will be described within this chapter.

The Symptom Management Model

The Symptom Management Model (Dodd et al., 2001; Larson et al., 1994) is a useful framework when considering a subjective experience that reflects changes in biopsychosocial functioning or cognition of an individual. It helps to conceptualize selection of management strategies and can be easily generalized. The Model for Symptom Management was originally developed by researchers at the University of California, San Francisco School of Nursing Symptom Management Faculty Group as a way of focusing on symptom experience, management strategies, and outcomes (Larson et al., 1994). The model was revised in 2001 to reflect changes in the model that allows incorporation of evidence to support collaboration and integration of science from other fields of research. The original Symptom Management Model (Larson et al., 1994) was developed on the premise that the experience of a symptom, how the symptom is managed, and the outcome of the management strategy are all interrelated and that experiencing a symptom can "not only create distress, but also disrupt social functioning" (Dodd et al., 2001, p. 669). The Revised Model (see Figure 3.1) re-evaluated the relationships among the dimensions of symptom experience, management, and outcomes based on research and experiential findings to reflect the domains of nursing science, person, health/illness, and environment and their influence on the dynamic nature of the model (Dodd et al., 2001).

Figure 3.1



Reprinted with permission. Dodd et al. (2001). Advancing the Science of Symptom Management. *Journal of Advanced Nursing* 33(5), 668-678.

Symptoms are important cues that allow problems to be recognized and strategies to be developed to help alleviate symptoms. The subjective nature of the symptoms can lead to various definitions, interpretations, and perceptions. They can exist individually or with other symptoms, which Dodd et al. (2001) call "symptom clusters" (p. 675). The way in which the symptoms are expressed is dynamic and rapidly changing. However, perception or lack of perception of a symptom does not imply that an individual is experiencing optimal health and well-being or that a symptom does not exist.

The model is based upon six assumptions. Firstly, symptoms are perceived by the individual and are based on the individual's self-report. The individual may be at risk for developing the symptom(s), and strategies to intervene may be initiated before the individual experiences any symptom(s). All troublesome symptoms need to be managed and the management strategy or intervention may be targeted at the individual, a group of individuals, a family, or a work environment. Lastly, the management of symptoms is dynamic and may be modified, depending on the individual or their environment.

The model recognizes that the domains of nursing science, person, health and illness, and environment all influence the three dimensions of the model: symptom experience, how the symptoms are managed, and the outcomes related to the symptoms.

Domains of Nursing Science

Person Domain

The Symptom Management Model is useful when considering how the person, the critical care nurse, perceives the symptom experience and how the person then responds to the experience. The variables of the person, including demographic information, and psychological, sociological, and physiological components are all fundamental to the way the situation is appraised and the way that person responds to the situation. These variables are intrinsic and effect how one views a symptom. They "exist before the symptom, influence the perception of the symptom, and, in turn, may be influenced by the symptom" (Larson et al., 1994, p. 274). Demographic variables include age, gender, marital status, and education. Psychological variables include personality, cognitive ability, coping style, and motivation. Sociological variables include the family unit, and number of dependents. Physiological variables include normal rest and activity patterns, physical capacity, and co-morbidities. The individual may be at risk for symptoms because of environmental factors, such as shift work within the ICU, the home environment, social supports, and beliefs and values. The symptoms can be anticipated, prevented or diminished by modifying the environment or assessing the factors that influence the perception of symptoms.

Health and Illness Domain

Individuals may be at risk for symptom development related to a number of factors that may have a direct or indirect effect on the symptom experience. Risk factors can be behavioral and/or hereditary. Occupational hazards, like shift work, may be identified and measured using the Symptom Management Model. Since it has been suggested that irregular work hours affects more than just the individual's sleep and wake patterns, the model allows for assessment of the many factors such as the social, physical, and psychological influences that are potentially hazardous to the well being of the individual. These factors may influence the perception of a situation and this may, in turn, influence the evaluation and response by the individual. Awareness of the hazards or risks should allow the individual to anticipate and seek management strategies to prevent or reduce the influence these hazards may pose, thereby diminishing any potential symptoms that may be experienced.

Environmental Domain

The physical, social, and cultural variables that make up an individual's environment all provide a context within which a symptom occurs. The environment influences the selection of management strategies and the outcome of the chosen strategies. The work environment, the home setting, cultural beliefs, and values as well as the activities the individual participates in all affect the perception of a symptom experience. Working the night shift in a world that is primarily geared toward the day time affects how well one sleeps, how often one must adjust sleep schedules to allow for participation within the family or social network, and one's level of fatigue.

The Symptom Experience

According to Larson et al. (1994), "symptoms are the most common reason people seek healthcare" (p. 272). The symptom experience is a dynamic interaction between how one perceives a symptom, the meaning they assign it, and how they respond to the symptom. Armstrong (2003) defined the symptom experience as "the perception of the frequency, intensity, distress and meaning occurring as symptoms are produced and expressed" (p. 602). The University of California, San Francisco School of Nursing Symptoms Management Faculty Group, (Larson et al., 1994) describes symptom experience as a dynamic and subjective perception that includes the evaluation of the meaning of a symptom and a response to a symptom. Thus, how critical care nurses perceive working the night shift and its effect upon their sleep/wake cycle will impact how they judge the situation. This in turn, will impact their thoughts, feelings, and behaviors about the effect of working the night shift and will effect how their health is perceived to be affected. This allows one to modify both how the situation is evaluated and how one responds, which continues to modify the perception of the symptom. Likewise, they may not perceive any effect and their behaviors may not change at all. Larson et al. (1994) contend that unless the opportunity to explore the symptom experience is presented, the opportunity to learn more and participate in the management of the symptom is denied. This may lead to further symptom development and alterations in health condition. Therefore, the symptom experience is multidimensional and includes the individual's perception of a symptom, the meaning the individual assigns to the symptom, and how they respond to the symptom. The manifestation of the symptom is personal. It is the interaction between these factors that influence the perception, evaluation, and response.

Perception

Perception of symptoms, in this study, refers to "whether an individual notices a change from the way he or she usually feels or behaves" (Larson et al., 1994, p. 273). There are a number of factors that influence the perception of a symptom. Among them are the environmental factors such as the physical environment, and the social and cultural context within which the symptom is experienced. Technology can be used to enhance the description of a symptom experience and medications can be used to alter the perception. Personal characteristics such as psychological, physiological, and sociological factors, stage of development, and demographic factors also affect how the symptom is perceived and the meaning that is assigned to the symptom. For critical care nurses, it then becomes important to understand how their sleep and wake patterns are perceived within the context of the person, their environment, and how this affects their health or illness status. Thus, the shift-work experience, demands upon the nurse from responsibilities outside the work place, as well as demographic factors such as age and stage of development, years of experience, and support systems, all influence the perception of their health or illness status.

Evaluation

How one evaluates a symptom reflects a complex set of factors about the symptom experience, including when, where, and how often the symptom is experienced. It is the judgment that is made about the symptom such as its severity, intensity, cause and treatability. Also, any impact related to how the symptom is characterized and whether or not the threat posed by the symptom is dangerous or disabling is evaluated (Dodd, 2001; Larson et al., 1994). The meaning assigned to a particular symptom is influenced by the frequency or duration of the symptom. For example, a person who has worked the night shift for years may describe the symptoms experienced in greater detail than one who has worked only one night shift and is less familiar with the experience. If the experienced person has learned to cope with night shift and does not view it as disabling, they may not describe the experience with the same intensity as one who views working nights as a health risk that impacts their life to a greater extent.

Response

An individual's response to a symptom or group of symptoms includes physiological, psychological, sociological, and behavioral components (Dodd, 2001; Larson et al., 1994). Physiological responses are the physical manifestations of the symptom, such as alteration in sleep/wake patterns, difficulty staying awake, and inability to fall asleep. Psychological responses include changes in mood, inability to concentrate, decreased empathy, and alterations in ability to cope. The sociological components may include changes in relationships or employment. The behavioral responses are "the objective expressions of a symptom and include verbal or social communication" (Larson et al., 1994). Changes in sleep/wake patterns, changes in mood, cognitive function, and role performance may be among the responses to a particular symptom or group of symptoms. In addition, a change in one response to a symptom may activate other responses. For example, if a critical care nurse working the night shift experiences difficulty staying awake during the night, the nurse may choose to nap and this may, in turn, alter the ability to sleep during the day, potentially leading to a cycle of insomnia.

Symptom Management Strategies

Symptom management is a dynamic process with the goal of providing relief from symptoms, preventing symptoms from occurring, and reducing negative outcomes that may occur because of the symptoms. In order for symptom management strategies to be developed, a careful and comprehensive assessment to determine the etiology of the symptom must be carried out from the individual's perspective. Once the cause of a symptom is determined, targeted interventions may be developed to achieve positive outcomes for the individual. This process may require frequent changes in strategies based either on need or the situation at hand.

One intervention that may reduce the symptoms of sleep deprivation, particularly related to shift work is the provision of napping areas. Sleep deprivation can lead to serious symptoms for the nurse, which can in turn have serious consequences for the patient and society in general. It has been reported that night shift has two major consequences: lower alertness during the night shift and shorter sleep with lower restorative value (Bonnefond et al., 2001). These factors lead to increased sleepiness and fatigue.

Napping during work hours might lead to short and long-term benefits on the workers' performance, well-being and health. Well rested workers are also believed to have increased central nervous system arousal, faster reaction times, improved mood and overall work performance (Kemper, 2001). According to Muzet, Nicolas, Tassi, Dewasmes, and Bonneau (1995), a short nap taken in the early part of the night increases vigilance and performance levels in the following hours. It is recommended that naps be either very short, between 20-30 minutes, or long, about 90 minutes to offset sleep inertia (1995). Napping during work may allow workers to find more energy as well as increase accuracy and greater endurance levels.

Adherence to intervention strategies depends on a number of factors including the characteristics of the person who is the target of the intervention; the effect the intervention has on their health/illness status, and the influence of the environment in which they find themselves. Thus in order to effectively manage symptoms, assessment of the symptom experience is essential from the individual's perspective.

Symptom Outcomes

In the revised Symptom Management Model (Dodd et al., 2001), the outcome dimension focuses on eight factors. The factors that fall within this dimension include quality of life, mortality and morbidity, emotional status, functional status, ability to care for self, healthcare utilization, and financial outcomes. These all relate to each other as well as the symptom status. The outcomes arise from the management strategies that are chosen, as well as the experience itself. For example, critical care nurses who work shift may experience symptoms of fatigue and this may result in utilization of strategies such as altering work schedules to work only the day shift, which in turn may lead to financial implications such as increased daycare costs and foregoing of shift premiums. This then, may impact the quality of life for the nurse. There is not a "cause and effect" relationship, but rather one that is multifactorial. Each factor may relate to one or all of the other factors. If the symptom is treated successfully, or has been resolved, the model is no longer relevant. However, if interventions are required continuously in order to control symptoms, then the model can be used to help to direct the management of the symptoms and to measure the outcomes.

Application of the Revised Symptom Management Model

The Revised Symptom Management Model was chosen to guide this study because it provides a useful framework that focuses upon the symptom experience, management strategies, and the outcomes of the symptoms. The model is dynamic and recognizes the domains of nursing science and their influence upon the individual's perception of a symptom. The model's scope is broad, and therefore, it is beyond the scale of this study to fully investigate all dimensions of the Symptom Management Model.

Thus, this study focused upon the symptom experience and the outcomes that are associated with the symptoms. The primary focus was to describe the domains of nursing science; the person factors, health and illness, and the environment within which the individuals live. In addition, the perception of symptoms, both subjective and objective, such as feelings of sleepiness and wakefulness, and the response to the symptoms are described. Any outcomes, related to the symptoms are presented. As well, any management strategies influencing the sleep/wake patterns that were reported within the course of the study are described. Understanding the experience of shift work among critical care nurses and its effect upon their sleep/wake patterns will assist both nurses and their employers to understand the symptom experience. This in turn may help both to work toward developing strategies to manage the symptoms that will allow for positive outcomes for the nurse and the patients for whom they care.

Domains of Nursing Science

Person Factors

The person variables include the demographic, psychological, sociological and physiological factors that are fundamental to the way an individual views and responds to the symptom experience in the Revised Symptom Management Model. The variables that were selected for this study to describe the population of interest include age, gender, marital status, education level, years of experience as a nurse and a critical care nurse in particular, and lastly the number of dependants the subject has.

Age

Over 25% of Canadians between the ages of 18-54 reported working shift in 2000-2001 (Shields, 2002). The average age of registered nurses in Canada, in 2005, was 44.7 years and in critical care areas, in Canada, the average age was slightly younger at 41.7 years (Canadian Institute of Health Information, 2005).

According to Shields (2002), the likelihood of working shift decreases as one ages. She suggests that this may be due to the fact that older workers may have more seniority, or people change their work situation as they find it more difficult to cope with the effects of shift work. In addition, intolerance to shift work may be due to changes in circadian rhythms that occur as individuals reach their forties and fifties (Costa, 1997; Learhart, 2000; Poissonnet & Vernon, 2000). Older people also may have difficulty achieving sleep that is uninterrupted and sufficient in length even under ideal conditions and may have an even more difficult time tolerating shift work (Muecke, 2005). Thus, the age of the nurse needs to be considered in order to describe the population of interest.

Gender and Marital Status

Gender is an important variable to consider. According to Shields (2002), the evening shift is more problematic for men than for women. She suggests that women may be better able to cope with the evening shift because they generally choose to work these schedules to care for family, while men work these schedules because of requirements of the job. Married men who worked the evening shift or rotating shift also reported more relationship difficulties with their spouse and those who were single found it more difficult to find a partner than those who worked a regular shift schedule (Shields, 2002). Females, on the other hand, express stress related to numerous demands, including caring for dependants (Shields, 2002; Wilson, 2002). Given that 92.6% of critical care nurses are female (CIHI Statistics, 2005), it is imperative to collect information related to this person factor to adequately describe this population.

Education and Years of Experience

Nurses who work in intensive care areas in tertiary care facilities are generally required to obtain additional education in order to specialize in critical care nursing. According to a study by Aiken, Clarke, Cheung, Sloane and Silber (2003), a higher proportion of nurses holding a bachelor's degree resulted in a decreased mortality level in patients. Understanding the education level of these critical care nurses will assist to identify any differences in responses that may be related to performance. That is, is there a perception that performance is impaired, and if so, is it because of lack of education and experience or because of effects of working shift?

Also, it is important to gain an understanding of how long these nurses have worked shift. As suggested by Marquié and Foret (1999), "there is some sort of selection process that excludes workers who are no longer able to meet the demands of shift work" (p. 303). Those who work shift within the critical care units may do so because they are more junior nurses or because they are experienced and are able to tolerate shift work better than those who have left. Dodd et al. (2001) suggest that experienced individuals, those with long histories of specific symptoms, may learn to catalogue the symptom and the quality of description of the symptom can be expected to be fuller and richer than less experienced individuals. Therefore, in order to accurately describe the population of study, information about their education and experience must be collected.

Number of Dependants

Nurses who work within the critical care environment are, on average, 41.7 years of age in Canada (Canadian Institute of Health Information, 2005). This group, therefore, are likely to have completed child bearing age, but may have young children at home and have parents who are senior citizens. Many of these nurses are women and often they have a number of domestic obligations such as child care responsibilities and maintaining the home that interfere with adequate sleep. Consequently, it is necessary to understand the factors, including outside work or domestic responsibilities that influence the environment in which the critical care nurses are living, to adequately describe this population.

Symptom Experience

Perception

A number of tools were utilized to identify the critical care nurses' perception of symptoms. According to Dodd et al. (2001), for a self-report of symptoms to be valid, the person reporting must respond to the perception of a symptom. However, they are often limited by boundaries imposed by the instruments that are selected to measure responses (Dodd et al., 2001). In order to increase validity of responses, nurses were asked to answer questions about their normal sleep and wake habits. They were asked to rate their level of fatigue and whether or not they experience daytime sleepiness. The instruments will be fully described in the Methodology section of this paper. In addition to self-reports, wrist actigraphy was utilized to quantitatively measure sleep. This technology is useful to describe the symptom experience when perception is potentially subconscious or distorted.

Evaluation

Sleep logs and questionnaires were utilized to characterize the symptom experience. Subjects were asked to score their likelihood of falling asleep, ability to stay awake, and they were asked to rate the quality and quantity of the sleep they do have. The evaluation of a symptom is complex. How a symptom is evaluated may dictate how the subject responds and manages the symptom.

Response

Subjects were asked to describe their usual sleep/wake patterns and any interventions they utilize to assist their sleep. If the subject perceives that they are experiencing sleep deprivation, either physiologically, psychologically, or behaviourally or that their social environment is being impacted by shift work, they may respond by either changing their work situation or one of the other dimensions in order to cope effectively with the symptoms they perceive and evaluate as significant.

Symptom Management Strategies and Outcomes

Any symptom management strategy may be targeted at one or more of the components of the individual's symptom experience (Dodd et al., 2001). Management strategies that are identified will be described, however, specific strategies and outcomes were not the focus of this study.

Conclusion

Critical care nurses care for patients who require continuous assessment, intervention, and vigilance, regardless of time of day or night. This work environment places critical care nurses at risk for sleep deprivation. Nurses in general, and critical care nurses specifically, have often been overlooked in the sleep literature. There have been very few studies related to the effect of shift work on the quality and quantity of sleep experienced by this group. Sleep is a basic human need that is restorative in nature. Sleep deprivation, on the other hand, has numerous detrimental effects, including decreased attention span, reduced motivation, irritability, memory lapses, diminished reaction time, and impaired performance. Those who are sleep deprived are often unable to recognize their impairment, putting both themselves and their patients at increased risk of injury, accident and error. It is important to gain a better understanding of the sleep and wake patterns, and the impact of shift work on critical care nurses in order to understand some of the challenges faced by this group. This will help to determine interventions to decrease sleep deprivation in these nurses who work shift and potentially to reduce the safety risks for the patients who are under their care.

Chapter 4

Methodology

This chapter will present the research design and methodology that was used for this pilot study. Information regarding the sample, setting, and the measurement tools that were used are fully described. As well, the study procedures and the ethical considerations are provided.

Design

This pilot research study utilized a non-experimental descriptive correlational design. The purpose of a descriptive study is to "observe, describe and document aspects of a situation as it occurs naturally" (Polit & Beck, 2004, p. 192).

Correlational research is used to understand a relationship among variables. In this study, the independent variables are the type of shift critical care nurses work and their socio-demographics. The dependent variables are the effects upon their sleep and wake cycles and any symptoms experienced as a result of working shifts. The overall aim of this study is to describe the relationship between the type of work schedule critical care nurses practice in, and the effect upon their sleep and wake cycles.

Much has been written describing the effect of sleep deprivation upon performance, but there have been few studies specifically analyzing the sleep/wake cycle of critical care nurses who work shift. Therefore a pilot study was undertaken in preparation for a future study to determine the type of interventions that may facilitate enhanced sleep and wake health practices in critical care nurses.

Study Setting

The study was conducted at a large university affiliated hospital in a mid-western Canadian city. Selection of this site was based on the size of the institution and the fact that it has the highest number of critical care units in the city. There are two adult intensive care units (ICU), one pediatric intensive care unit, and one neonatal intensive care unit. The nursing teams within these units are comprised of nurses who work a variety of shifts, from straight day shifts, evening or night shift only, to a combination of shifts. In addition, there is a variety of 8-hour and 12-hour shifts and differing levels of experience and years of service.

Subject Selection

The subjects in this study were registered nurses who are currently employed in one of the four intensive care units at the facility. A non-probability convenience sample of adult critical care nurses drawn from the four intensive care units was recruited.

Inclusion Criteria

Inclusion criteria for those eligible for this study were:

1) 18 years of age or older;

2) Able to speak and write English fluently;

3) Willing to participate in the study;

4) Have worked a minimum of six months in the designated ICU;

5) Work a minimum of 0.6 Equivalent to Full-Time (EFT), which is at least 24 hours/week;

6) Work 12-hour shifts.

Exclusion Criteria

Exclusion criteria included:

1) A self-reported, previously diagnosed sleep disorder;

2) Working only during the day shift;

3) Working less than a 12-hour shift on a regular scheduled basis.

As this was a pilot study, the potential number of critical care nurses working within the four ICUs and who meet the selection criteria determined the sample size. There are approximately 50 nurses working in each of the intensive care units, resulting in an approximate sample size of 200 critical care nurses. All nurses who agreed to participate, who met the inclusion criteria, and the data collection time frame, were accepted. The data collection phase extended over a two-month period. This time period allowed sufficient time for the subjects to wear the actigraphy for ten consecutive days. With availability of four actigraphs, the potential sample size was twenty-four.

Method

Procedure

Data collection began after ethical approval was obtained from the *Education and Nursing Ethics Review Board* of the University of Manitoba and site access was obtained.

The Managers of Patient Care for each of the selected ICUs were contacted and the investigator arranged to attend staff meetings or program team meetings where a description of the proposed study was presented and nurses were invited to participate. In addition, a flyer with the researcher's contact information was left on the units asking for volunteers. The voluntary nature of staff participation was stressed. Nurses, who were interested, were encouraged to phone the investigator at the number provided to learn more about the study. Arrangements were made to meet face-to-face at a mutually convenient time and location, at least two days prior to the start of a work shift. At the time of this meeting, the investigator discussed informed consent in accordance with the policies and procedures at the facility as outlined by the *Research Review Board*. Two copies of the consent were signed and one signed copy remained with the investigator; the second was left for the participant's records.

Once informed consent had been obtained, the investigator asked the subjects to fill out the following; a demographic questionnaire (Appendix A); a 10-item sleep quality index, the Pittsburgh Sleep Quality Index (PSQI) (Appendix B); and to assess the subject's usual sleep habits, the Sleep Timing Questionnaire (STQ) (Appendix C). The estimated time of completion for these three items was between 15–30 minutes. Upon completion of the questionnaires, subjects were instructed regarding the use of the Actiwatch®. During this meeting, the researcher provided the subject with the Actiwatch® and a folder containing: a) a Sleep Log, which they were asked to complete for each of the 10 days of data collection; b) written instructions on the care of the Actiwatch®; and c) the Epworth Sleepiness Scale (ESS) (Appendix D), which they were instructed to complete on each of the 10 days, after they determined that they were awake and ready to start their day (Table 4.1). Completion of the ESS was reported to take less than 5 minutes. Completion of the Sleep Log took less than 10 minutes per day. On day 2 and day 9, the researcher contacted the subject at an agreed upon time, to answer any questions and to arrange a time to retrieve both the Actiwatch® and folder containing the Sleep Log and Epworth Sleepiness Scale. Ideally, the items were retrieved on day 10. Occasionally, the items were retrieved on day 11 or 12. Subjects were each offered a summary of the published results, a copy of their sleep/wake summary upon completion of the study, and a gift certificate valued at $5.00 for a local coffee shop as a small token of appreciation.

Table 4.1 Instrument Administration Schedule

	Initial meeting	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Extra
Consent	√											
PSQI	√											
STQ	√											
Demographic Questionnaire	√											
Sleep Log		√	√	√	√	√	√	√	√	√	√	
Actigraph		√	√	√	√	√	√	√	√	√	√	
ESS		√	√	√	√	√	√	√	√	√	√	√

Note: PSQI = Pittsburgh Sleep Quality Index, STQ = Sleep Timing Questionnaire, ESS = Epworth Sleepiness Scale

Instruments

Patient demographic questionnaire. The demographic questionnaire, developed by the investigator (Appendix A) collected information about the nurse's age, gender, level of education, marital status, length of time practicing and working in the ICU, work status (full-time, part-time) and regular shift pattern (day/night or night only). In addition, information about the number and age of any dependents was collected. This information was used to describe the sample.

The Pittsburgh Sleep Quality Index. The Pittsburgh Sleep Quality Index (PSQI: Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) (Appendix B) provides a widely used, standardized quantitative measure of sleep quality and compares favorably with clinical and laboratory diagnoses of good and poor sleepers. It is a 19-item questionnaire that measures seven components of sleep quality, including self-rated estimates of sleep duration and how long it takes to fall asleep. Each of the seven components are weighted equally on a 0-3 scale and the scores are summed to yield a global score between 0-21. The higher the score, the poorer the quality of sleep. A PSQI global score > 6 is recommended to differentiate between good sleepers and those who suffer from sleep disturbances (Backhaus, Junghanns, Brooks, Riemann, & Hohagen, 2002).

The validity of the PSQI has been demonstrated by comparing the PSQI to polysomnography tests. No significant differences were noted between the PSQI and laboratory findings (Buysse et al., 1989). The PSQI is not as sensitive as the polysomnography, but this is due to the fact that the PSQI estimates the preceding month's usual sleep duration and efficiency, rather than the daily variability noted in the laboratory setting (Buysse et al., 1989). This tool has been shown to be useful with good validity for patients with psychiatric and sleep disorders (Buysse et al., 1989; Doi et al., 2000), as well as those considered 'healthy' elderly subjects (Buysse et al., 1991).

The seven components of the PSQI have a high degree of internal consistency ($\alpha = .83$), indicating that each component measures sleep quality. Test-re-test reliability has been conducted on the global scores ($\alpha = .85$), sleep latency ($\alpha = .84$) and use of sleep medication ($\alpha = .65$) using Cronbach's coefficient alpha (Buysse et al., 1989).

The Epworth Sleepiness Scale. The Epworth Sleepiness Scale (ESS: Johns, 1991) (Appendix C) is a self administered eight-item questionnaire that measures daytime sleepiness in adults. This scale measures the likelihood of falling asleep. Subjects were asked to rate particular situations based on the likelihood that they may doze during the day, with 0 indicating "would never doze" to 3 indicating a "high chance of dozing" (Johns, 1991). ESS scores range from 0 to 24 and greater than 10 indicate a high level of daytime sleepiness (Johns & Hocking, 1997), while total scores of 5.9 ± 2.2 have been noted in normal control subjects (Johns, 1991).

The ESS is highly correlated with sleep latency measured with multiple sleep latency tests during the day and polysomnography at night (Johns, 1991). Pilcher, Pury and Muth (2003), suggest that the ESS is a subjective measure of the behavior of falling asleep, but it may not be adequate to use only one measure of subjective sleepiness. They suggest that more than one tool be used to assess the likelihood of falling asleep. However, Chervin, Aldrich, Pickett, and Guilleminault, (1997) found that the ESS had good internal and test-re-test reliability and did appear to have moderate correlation with objective measurements. As this tool is simple and reliable, it was chosen as one method to measure daytime sleepiness. The ESS takes less than five minutes to complete and subjects were asked to complete this survey eleven times during the data collection period.

The Sleep Log. The Sleep Log (Appendix D) is a self-administered daily report that asks about various aspects of the sleep experience. It is a simple and inexpensive way to document the frequency and severity of the effect of symptoms upon daily activities (Rogers, Caruso & Aldrich, 1993).

The Sleep Log asks subjects to estimate: how long they slept, or their total sleep time (TST); how long it takes to fall asleep, or their sleep onset latency (SOL); if they woke up after falling asleep, which is known as waking after sleep onset (WASO); and how long they were awake, their total wake time (TWT). They were also asked to indicate any difficulty they had falling asleep, the number of times they woke up too early, whether the time spent in bed was efficient (SE), their normal bedtime, wake time, total time in bed, and if they required any assistance to fall asleep, such as medication. Lastly, they were asked if they nap during the day and if so, how often and when.

The Sleep Log does have some drawbacks. Some suggest the data may not be complete or accurate as it may reflect atypical sleep experiences (Buysse et al., 1991); it is unknown how many nights of monitoring are required for accuracy (Edinger, Marsh, McCall, Erwin, & Lininger, 1991), and it may be reactive and may cause either improvement in sleep, or deterioration (Fichten et al., 1995). However, the Sleep Log has been demonstrated to be a reliable instrument. Rogers, Caruso and Aldrich (1993) found that when compared to polysomnographic data, the Sleep Log demonstrated high sensitivity and specificity (p. 371). Libman, Fichten, Bailes and Amsel (2000) found high correlations between retrospective sleep measurement and the Sleep Log. The correlation between instruments was particularly high for total sleep time ($r = .832$, $p < .001$), sleep efficiency ($r = .772$, $p < .001$), and time in bed ($r = .769$, $p < .001$). Libman et al. (2000) suggest that the daily sleep log "can pinpoint variations in the night–to-night sleep experience, and shed light on sequences of events" (p. 207). This would, therefore, allow variations in activities to be accounted for, but took 10-15 minutes to complete each day.

The Sleep Timing Questionnaire. The Sleep Timing Questionnaire (STQ: Monk, Buysse, Kennedy, Pods, DeGrazia, & Miewald, 2003) (Appendix E) is a single administration questionnaire that appears to accurately assess a person's habitual sleep timing. One problem Monk et al. (2003) identified with sleep diaries is that they require nightly commitment from subjects for a period of time, which the subjects may find burdensome. Thus the STQ was developed as an alternative to the sleep log. In this study, it was used as another method to assess a person's sleep habits. This instrument asks subjects to answer the questionnaire based on a recent "normal average week". They are asked to provide times that correspond to a "Good Night Time", a "Good Morning Time" and how much sleep is lost to unwanted wakefulness. This questionnaire takes 10-15 minutes to complete. This questionnaire was completed once during the initial meeting with the researcher. The test-re-test reliability for the STQ demonstrated good estimates of bedtime ($r = .71$) and waketime ($r = .8$), and convergent validity using wrist actigraphy demonstrated a correlation of 0.592 ($p < .005$) for bedtime and 0.769 ($p < .005$) for waketime. The STQ is highly correlated with a formal 2-week sleep diary ($r = .8$) and the mean estimates related to sleep latency with the STQ are within a few minutes of the diary estimates.

Actigraphy. Actigraphy has been used to study sleep/wake patterns for many years. It is a convenient way to continuously record sleep/wake activity, for 24-hours a day for days, weeks or even longer (Ancoli-Israel, et al., 2003). Actigraphs are small electronic devices that are placed on a wrist or ankle to record movement. It is a non-invasive, easy to use, relatively inexpensive, lightweight, portable instrument that is capable of detecting the quality and intensity of movement. It is the size of a wrist watch and is traditionally worn on the wrist, though some studies have reported data collection from leg application. The Actigraph wrist activity technology is based on the fact that during sleep, there is little movement, whereas during wakefulness there is increased movement. The digitalized data that are collected is downloaded to a computer. The data display activity and inactivity of the subject and this information can be used to estimate sleep/wake patterns. With each subject movement, an accelerometer generates a variable voltage that is digitally processed and sampled at a frequency of 32 Hz. The signal is integrated over a user-selected epoch and a value expressed as "Activity Counts" is recorded in on-board memory. The computer scores sleep and wake and can provide the user with information about total sleep time, sleep efficiency, number of awakenings, time between awakenings, and sleep onset latency, which is the time it takes to fall asleep (Ancoli-Israel, et al., 2003). The Actigraph has a movement detector and enough memory to record for up to several weeks. The recordings are continuous, so behavior occurring during day and night can be studied. The movement is sampled several times per second and stored for later analysis.

Based on standard sleep recommendations of the National Sleep Foundation (NSF), healthy adults should: receive 7-9 hours of sleep per night; have a sleep efficiency (SE), or the ratio of time in bed to total sleep time, of greater than 85%; have a minimal number of awakenings of brief duration; and have a sleep onset of less than 30 minutes.

The Actigraph has been used in many studies. In a review paper by Ancoli-Israel et al. (2003), over 60 studies utilizing actigraphy were described and summarized. In a study by Friedman et al. (2000), wrist actigraphy estimation correlated with polysomnographic estimation of total sleep time (r =. 96), sleep efficiency (r = .63), sleep latency (r = .72), and wake after sleep onset (r = .68). It is suggested that "the increasing experience in the use of actigraphy in a variety of populations, conditions and settings…enables studies involving multiple days and nights of testing…and clinical trials of sleep/wake activity" (Ancoli-Israel et al., 2003, p. 353).

This study used the Mini Mitter –AW64 Actiwatch, which is a small, lightweight unit (28 x 27 x 10mm, 17g). Four Actiwatches were made available to the researcher by Dr. D. McMillan, Faculty of Nursing, along with access to scoring software. Subjects were asked to place the unit on their non-dominant wrist and to wear the device for 10 days. They were asked to avoid any heavy contact and to try to keep the device dry. If they must remove the device, subjects were asked to record the time of any removal, the reason why the device was removed, and when the device was replaced. The activity level was measured in counts per 30-second epoch, with one activity count being any movement that is sufficient to displace the internal piezoelectric transducer. The information was downloaded to the supervisor's computer through an interface unit and then was scored using a dedicated software package (Actiware software version 5.0). The Actiwatch® was initialized to begin recording at 2100 hours on the first night the subject began to wear the unit. On day 10 the unit was removed and the investigator retrieved the Actiwatch® for downloading and analysis.

Ethical Considerations

Three committees, prior to the commencement of the data collection, reviewed this study. A thesis committee consisting of the thesis supervisor and one internal member from the Faculty of Nursing and one external member from the Faculty of

Medicine provided approval after presentations of the proposal for study. In addition, permission to conduct this study was obtained from the *Education and Nursing Ethical Review Board* at the University of Manitoba and the Health Sciences Centre *Research Review Committee* for access.

Informed Consent and Confidentiality

A written consent from each subject was obtained prior to data collection and was numerically coded. Consent forms included the contact information of the investigator, thesis supervisor, and Human Ethics Secretariat. A copy of the consent form was given to the subjects for their records. All demographic forms was numerically coded and locked in a secure cabinet in the investigator's home. The surveys were also numerically coded and stored separately from the informed consent forms and the demographic information. Only the investigator had access to the subjects' identifying information. All electronic data was stored on a USB memory stick and was kept in a locked cabinet in the investigator's home. The actigraphic data studies were stored in secure password protected files in the supervisor's locked office. The data will be kept for a maximum of seven years, upon which time it will be destroyed. The destruction of the data will be done by using the services of a confidential paper shredder and the electronic data will be destroyed by crushing the USB memory stick.

Participant Involvement and Potential Risks

There was no deception or coercion associated with any of the procedures. Subjects were thanked by way of a small $5.00 gift certificate for a local coffee shop for their participation. Time was the primary investment required by the subjects. The initial interview and completion of questionnaires took 55-60 minutes. They were required to wear the Actigraph® for 10 days and asked to fill out the ESS and Sleep Log daily (10 – 15 minutes in total). The total time commitment for the study was less than expected, as subjects reported spending between 2 to 3 hours rather than the anticipated 2.5 to 3.5 hours. There were no perceived risks or legal implications for the subjects and no harmful effects were reported. The Actiwatch® was safely worn during patient care, and it did not interfere with patient monitors or electrical equipment. Every effort was made to provide researcher subjects with information and support as required.

Data Analysis

A variety of statistical tests were utilized to analyze the data collected. All data were reviewed for completeness prior to entering them into a computer database for analysis. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) 11.0 version computer software program. A statistician (M. Cheung) from the Manitoba Nursing Research Institute (University of Manitoba) was consulted to provide guidance during all phases of data analysis and interpretation. In order to describe the population being studied, demographic information related to the subject's age, gender, marital status, number of dependents, years of experience as a critical care nurse, level of education, and type of shift rotation normally assigned, was collected. Descriptive statistics were used to generate information to characterize the population in terms of socio-demographic variables.

In order to answer the question regarding the comparison between the sleep/wake patterns of critical care nurses and normative data, results from the ESS, PSQI, STQ, Sleep Logs and Actigraphy® were compared. The normative data from the ESS and PSQI were compared to the standard cut points that have been described in the literature.

To describe the self-reported experience of sleepiness in critical care nurses across dayshift, nightshift, and non-shift days, the ESS was compared using a repeated measures ANOVA test. The significance level was set at $p = .05$.

The nurses' rest and activity, specifically the total sleep time (TST), sleep onset latency (SOL), waking after sleep onset (WASO), time in bed (TIB), and sleep efficiency (SE), were measured using the Sleep Log and actigraphic data. Sleep Log mean data was summarized and the Sleep Log ordinal data was compared using Spearman's rho with a significance level set at $p = .05$. Twenty-four hour actigraphy summary score data (TST in minutes, SL in minutes, WASO in minutes; TIB in minutes and SE in percent) were analyzed using a repeated measures ANOVA. To test sleep/wake patterns between specific work and non-work days, a within subjects repeated measures ANOVA test was utilized.

To detect associations between actigraphy scores and the self-reported sleep log, data were analyzed using Spearman's rank correlational tests. A $p = .05$ was considered significant (Table 4.2).

Table 4.2 Summary of Concepts, Tools and Analysis Methods

Concept	Hypothesis	Tool	Level of Measurement	Analysis of Findings	Model RSMM
Description of subjects	Nurses are engaged in multiple roles	Demographic questionnaire (One time collection)	Nominal: marital status, education Interval: age, number of dependents	Frequency counts, percentages	Domain of Person
Measure of sleep quality and pattern	Nurses perceive there is a difference between work & non-work days	PSQI (One time collection)	Interval	Frequency counts, percentages	Symptom Perception
Self report of sleep timing	Nurses perceive stability of bedtime between work and non-work days	STQ (One time collection)	Interval	Frequency counts, percentages	Symptom Perception and Experience
Measure of daytime sleepiness or wakefulness	There is a difference between work & non-work days.	ESS Sleep Log (daily for 10 days)	Ratio	Repeated measures (within subjects) ANOVA between work and non-work days	Symptom Experience
Self report of sleep experience Rest/Activity	There is a difference between work & non-work days..effected by shift work	Sleep Log/Diary (daily for 10 days)	Ordinal	Repeated measures ANOVA (within subjects)	Symptom Experience
Quantitative recording of sleep/wake pattern	There is a difference between work and non-work days and shift work effects this	Actigraphy (daily for 10 days)	Ratio	Repeated measures ANOVA and Spearman's rank correlation	Symptom Experience

Note: PSQI = Pittsburgh Sleep Quality Index, STQ = Sleep Timing Questionnaire, ESS = Epworth Sleepiness Scale

Summary

This pilot research study utilized a non-experimental correlational research design to describe the sleep/wake patterns of critical care nurses who work shift using both the nurses' self reports to obtain a subjective perspective and actigraphy to obtain an objective measure. The overall aim of this study was to describe the relationship between the type of work schedule critical care nurses practice in, and the effect upon their sleep and wake cycles. A non-probability convenience sample of adult critical care nurses was invited to participate and a number of instruments were utilized to describe the sleep/wake patterns of critical care nurses. The findings were interpreted and analyzed within the broader context of the Revised Symptom Management Model (Dodd et al., 2001).

Chapter 5

Results

This chapter provides the results of this non-experimental descriptive correlational pilot study exploring sleep and wake patterns in critical care nurses. The demographic characteristics of the sample are provided first, followed by the findings for each of the research questions that have been posed.

Demographic Data

Data collection occurred over a two-month period during October and November of 2007. Data were collected from critical care nurses who volunteered to participate from three critical care areas in a large, tertiary hospital. Nurses from one of the invited critical care units chose not to participate, despite repeated invitations to do so for undisclosed reasons. In addition, three critical care nurses who also volunteered to participate were excluded from the study due to scheduling and equipment constraints. Therefore, a total of 18 subjects were recruited. The demographic information about these subjects is presented in Table 5.1.

Table 5.1 Demographic Profile of Subjects

Characteristics	Total Sample (N=18)
Age Range	
21-30 years of age	4 (22.2%)
31-40 years of age	6 (33.3%)
41-50 years of age	5 (27.8%)
51-60 years of age	2 (11.1%)
>60 years of age	1(5.6%)
Gender	
Female	15 (83.3%)
Male	3 (16.7%)
Highest Level of Education	
College/Diploma Program	7 (38.9%)
Baccalaureate in Nursing	9 (50.0%)
Baccalaureate in other than Nursing	2 (11.1%)

Characteristics	Total Sample (N=18)
Specialty Certification in Critical Care	
Yes	6 (33.3%)
No	12 (66.7%)
Advanced Specialty Course	
Yes	14 (77.8%)
No	4 (22.2%)
Years as a Nurse	
6 months-5 years	3 (16.7%)
>5 years-10 years	4 (22.2%)
>10-15 years	4 (22.2%)
>20 years	7 (38.9%)
Years as a Nurse in the ICU	
6 months-5 years	8 (44.4%)
>5 years-10 years	4 (22.2%)
>10-15 years	2 (11.1%)
>20 years	4 (22.2%)
Current Occupational Status (FTE)	
0.6 (60% of Full-time)	1 (5.6%)
0.7 (70% of Full-time)	2 (11.1%)
0.8 (80% of Full-time)	5 (27.8%)
1.0 (Full-time)	10 (55.6%)
Normal Work Rotation	
Day/Night	18 (100%)
Marital Status	
Single/Never Married	5 (27.8%)
Married/Common-Law	12 (66.7%)
Divorced/Separated/Widowed	1 (5.6%)
Total Number of Dependents	
None	12 (66.7%)
1 Dependent	3 (16.7%)
2 Dependents	1 (5.6%)
5 Dependents	2 (11.1%)
Time spent on Domestic Factors	
0-4 hours	13 (72.2%)
>4-8 hours	5 (27.8%)

The majority of subjects were females (83.3%) and between 31 and 60 years of age (78%). Most had been nurses for at least 5 years, many for over 20 years, and slightly more than half of these nurses had been working in the ICU for over 5 years. All worked a day/night rotation and most were employed in positions that were at least 80%

of full-time. The majority of the nurses in this study had a Baccalaureate degree (61%), primarily in nursing. In addition, 67% had taken an advanced course in critical care nursing and one third had received certification in their specialty. The subjects were predominantly married, and one third had dependents, only 20% of which were between the ages of 0-15 years. The majority of dependents were adult children. Lastly, most participants spent up to four hours a day on domestic factors, such as housekeeping, grocery shopping or childcare.

Research Question One:

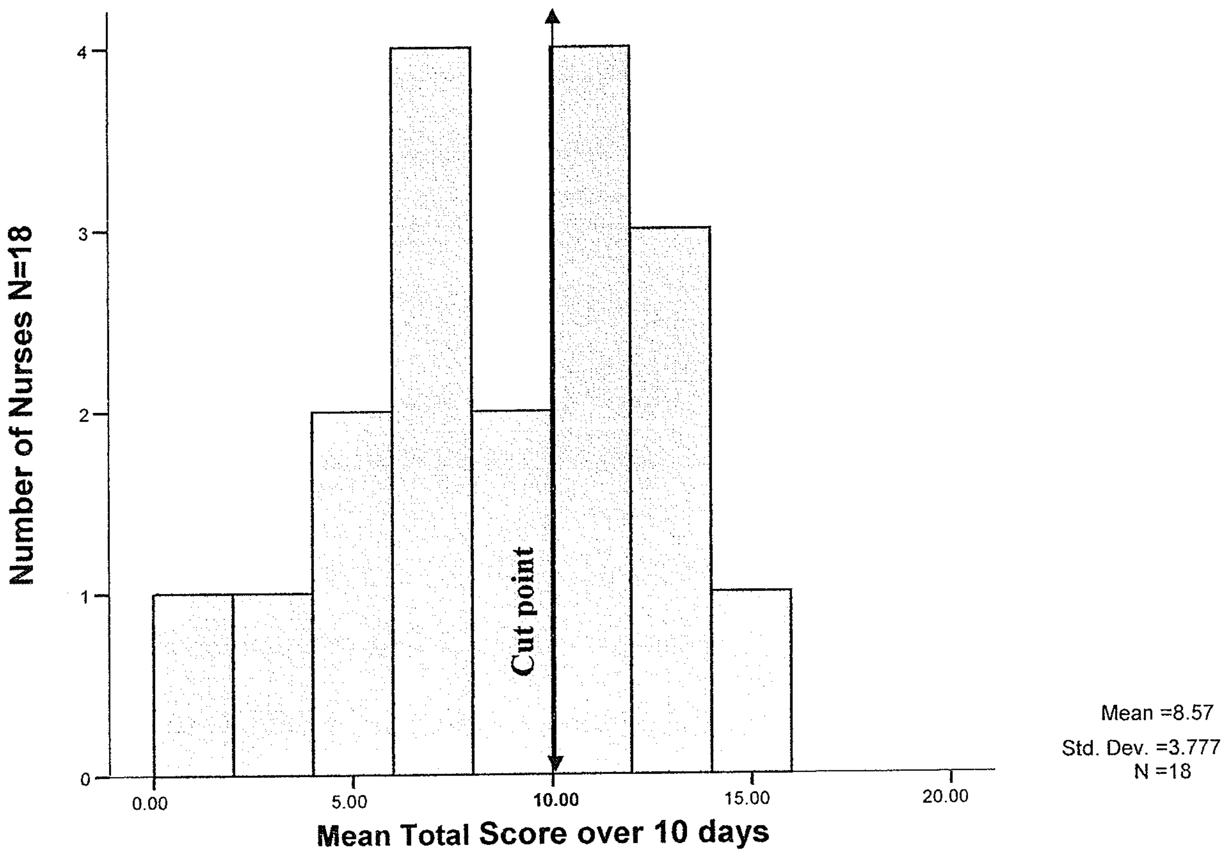
How Do the Sleep/Wake Patterns of Critical Care Nurses Who are Engaged in Shift Work Compare with Normative Adult Sleep/Wake Patterns?

The first question was answered through an analysis of the Epworth Sleepiness Scale (ESS: Johns, 1991), the Pittsburgh Sleep Quality Index (PSQI: Buysse, et al., 1989), the Sleep Timing Questionnaire (STQ: Monk, et al., 2003), Sleep Logs, and Actigraphy®. The normative data from the ESS and PSQI were compared to the standard cut points that have been described in the literature for these instruments.

Figure 5.1 summarizes the results of the mean total ESS scores (ESS: Johns, 1991). The ESS is a self-administered questionnaire that measures daytime sleepiness in adults. Total scores for the ESS can range from 0 to 24, with scores over 10 indicating clinically significant daytime sleepiness (Johns & Hocking, 1997). The mean total score for the critical care nurses, over the 10 days of data collection was 8.57 (SD $\pm$ 3.77; range 1.5 to 15.20). On any day, at least 30% of the nurses had scores of 10 and over, and on 4 of the 10 days, at least half of the nurses scored higher than the standard cut point. Eight of the eighteen nurses (44.4%) had an overall average score of greater than 10. When the

ESS was completed immediately upon returning home after finishing their last night shift, critical care nurses rated their mean ESS total score as 16.57 (SD ± 5.26) with a range of 6 - 23. Of the 18 nurses, 16 (88.88%) rated their ESS score above the standard cut point of 10 after completing their last night shift.

Figure 5.1 Mean Total Epworth Sleepiness Scale Scores of Critical Care



Note. Arrow indicates clinical cut point

The Pittsburgh Sleep Quality Index (PSQI: Buysse, et al., 1989), was completed once by each subject during the enrollment phase of the study and the resulting scores are summarized in Table 5.2. This questionnaire measures components of sleep quality, weighted equally on a 0-3 scale. The scores are summed to yield a global score between 0-21. A high score is indicative of a poorer quality of sleep. A PSQI global score > 6 is recommended to differentiate between good sleepers and those who suffer from sleep disturbances (Backhaus, et al., 2002).

The mean global score for the PSQI in this study was 8.42 (SD ± 2.93), which is at least 2 points higher on average than those who are considered "good sleepers". The global score for the PSQI ranged from 3 – 13. Of the respondents, 33% reported a mean global score of 5 or less; the remainder (76.7%), reported a poor quality of sleep based on a global score ≥ 6. The research criteria for insomnia suggests that sleep latency (SOL) or wake after sleep onset (WASO) of ≥ 31 minutes, occurring ≥ 3 times per week and ≥ 6 months indicate severe insomnia (Lichstein, Durrence, Taylor, Bush, &Riedel, 2003). Half of the respondents (n = 9) reported a sleep latency of up to 15 minutes. The remaining half (n = 9) reported taking between 15-90 minutes to fall asleep. One third (33.3%) of respondents reported a sleep latency greater than 45 minutes. Fifty percent of the subjects spent up to 7.5 hours in bed but slept less than 6.5 hours per night. The National Sleep Foundation (2005) recommends between 7-9 hours of sleep per night and only one subject reported sleeping 8.5 hours on average per night. Overall, two thirds of the respondents reported their sleep quality as "very good" or "fairly good", while the remaining one third described their sleep as "fairly bad". Three subjects (16.7%) reported having trouble staying awake "once or twice a week" and one person reported having trouble staying awake "three or more times a week".

Table 5.2 Pittsburgh Sleep Quality Index Mean Scores

Component	Mean ± SD (N = 18)	Range
Sleep Latency (minutes)	24.61 ± 23.01	1-90
Total Sleep Time (hours)	6.55 ± 0.95	5-8.50
Time in Bed (hours)	8.27 ± 1.59	6-11.50
Sleep Quality 1 = very good 2 = fairly good 3 = fairly bad 4 = very bad	2.17 ± 0.51	1-3
Trouble Staying Awake 1 = not during past month 2 = less than once/week 3 = once or twice/week 4 = three or more times/ week	1.83 ± 0.92	1-4
PSQI Global Score (0-21)	8.42 ± 2.93	3-13

The Sleep Timing Questionnaire (STQ: Monk et al., 2003) was administered once during the enrollment period. Table 5.3 summarizes the data related to the stability of bedtimes and wakeup times of subjects when they were working and when they were off. When asked to rate how stable their bedtime is when they are working, 55.6% (n = 10) of subjects reported their bedtime varied between 16-60 minutes. However, when participants were not working, 55.6% of the subjects reported bedtime varied up to 120 minutes. Two nurses reported bedtime variability of over four hours on a day off. With respect to wake up times, the majority (77.8%) of nurses reported that their wake up time varied up to 30 minutes on work days. When not working, 44.5% of the nurses reported that their wake up time varied from 2-4 hours.

Table 5.3 Sleep Timing Questionnaire Bedtime Stability

Component	Time	Frequency	Percent
Stable Good Night Time on Workday	<60 minutes	10	55.6%
	1hr - >4 hrs	8	44.4%
Stable Good Night Time on Day Off	0-120 minutes	10	55.6%
	2hrs - >4 hrs	8	44.4%
Stable Good Morning Time on Workday	0- 15 minutes	8	44.4%
	16 minutes - >4 hrs	10	55.6%
Stable Good Morning Time on Day Off	16 minutes - 120mins	9	52.9%
	2hrs - >4 hrs	8	44.4%
	Missing	1	2.7%

Sleep Logs were used by all subjects to collect subjective self-report information daily for 10 days. The information from these Sleep Logs is summarized in Table 5.4. Subjects reported an average total sleep time (TST) of 372.8 (SD ± 49.96) minutes, (range; 4.69 to 11.6 hours) over the 10-day period. It took between 4.5 to 41.5 minutes for subjects to fall asleep, with a mean sleep latency of 17.57 minutes (SD ± 10.45). When asked how often subjects awakened during their sleep period, answers ranged from 1 to 4 times over the 10 days, with the majority reporting waking 2.35 times per night (SD ± 0.94). Overall, subjects reported between 5 to 8 hours of sleep, with a mean sleep length of 6.61 hours (SD ± 0.85).

Actigraphy® data were collected from each subject over a 10-day period. Only four subjects had complete data for all 10 days. On day 1, the majority of subjects either put the watch on before it had been initialized or put the watch on hours after data collection was set to begin. This was in part due to the researcher's inexperience with the Actigraph technology and partially due to misinterpretation of instructions that had been provided. However, after the first day's data had been eliminated, the data were complete for the remaining nine days. The data were averaged for each subject and this data is summarized in Table 5.4. The mean time in bed (TIB) for the 18 subjects was 7 hours, 34 minutes, with a minimum of 5.68 hours and a maximum of 8.85 hours. The mean actual sleep time (TST) was 6.10 hours, (SD ± 55.01), with a minimum of 4.75 hours and a maximum of 7.5 hours over the data collection period. The average sleep efficiency for the 18 subjects was 78.59% (SD ± 5.69). The average sleep latency based on Actigraphy® was 25.56 minutes, with time to fall asleep ranging from 11 to 48 minutes.

Table 5.4 Actigraphy and Sleep Log Total Group Averages

Component	Instrument	Mean ± SD	Range
Sleep Latency (SOL) (minutes)	Actigraphy	25.56 ± 10.23	11-48
	Sleep Log	17.57 ± 10.45	4.5- 41.5
Wake After Sleep Onset (WASO) (minutes)	Actigraphy	44.32 ± 24.57	18-109
	Sleep Log	25.35 ± 27.67	60-180
Total Sleep Time (TST) (minutes)	Actigraphy	366.47 ± 55.01 (6.10 ± 0.91 hours)	285-450
	Sleep Log	372.8 ± 49.96 (6.21 ± 0.83 hours)	281- 486
Sleep Efficiency (SE) (%)	Actigraphy	78.59 ± 5.69	65-86
	Sleep Log	82.99 ± 7.17	66-94
Time in Bed (TIB) (minutes)	Actigraphy	454.41 ± 51.92 (7.57± 0.86 hours)	341-531
	Sleep Log	444.60 ± 53.53 (7.41 ± 0.89 hours)	287-519

Three actigraphy plots were selected to illustrate a variety of the sleep/ wake patterns. The spikes on the actigraph printout indicate periods of activity, and the higher the spike, the greater the activity level. Areas of rest are represented by little or no spikes. Each line represents 48 hours, the first half or right hand side represents the date to the right side of the plot, from midnight to midnight. The second half, on the left hand side of the line represents the next day. This line is repeated on the right side of the following line. Figure 5.2 reflects the rest/activity pattern of one subject who demonstrated a regular pattern of rest and activity. Figure 5.3 is a plot of the rest/activity pattern of a subject who consistently underestimated the amount of total sleep time on the Sleep Log and who subjectively reported sleep as "Good". Finally, the third plot, Figure 5.4, reflects the rest/activity pattern of one nurse who did not sleep for a period of 24 hours during the data collection period and rarely demonstrated extended periods of rest.

Figure 5.2 Actigraph plot for subject with regular rest/activity patterns

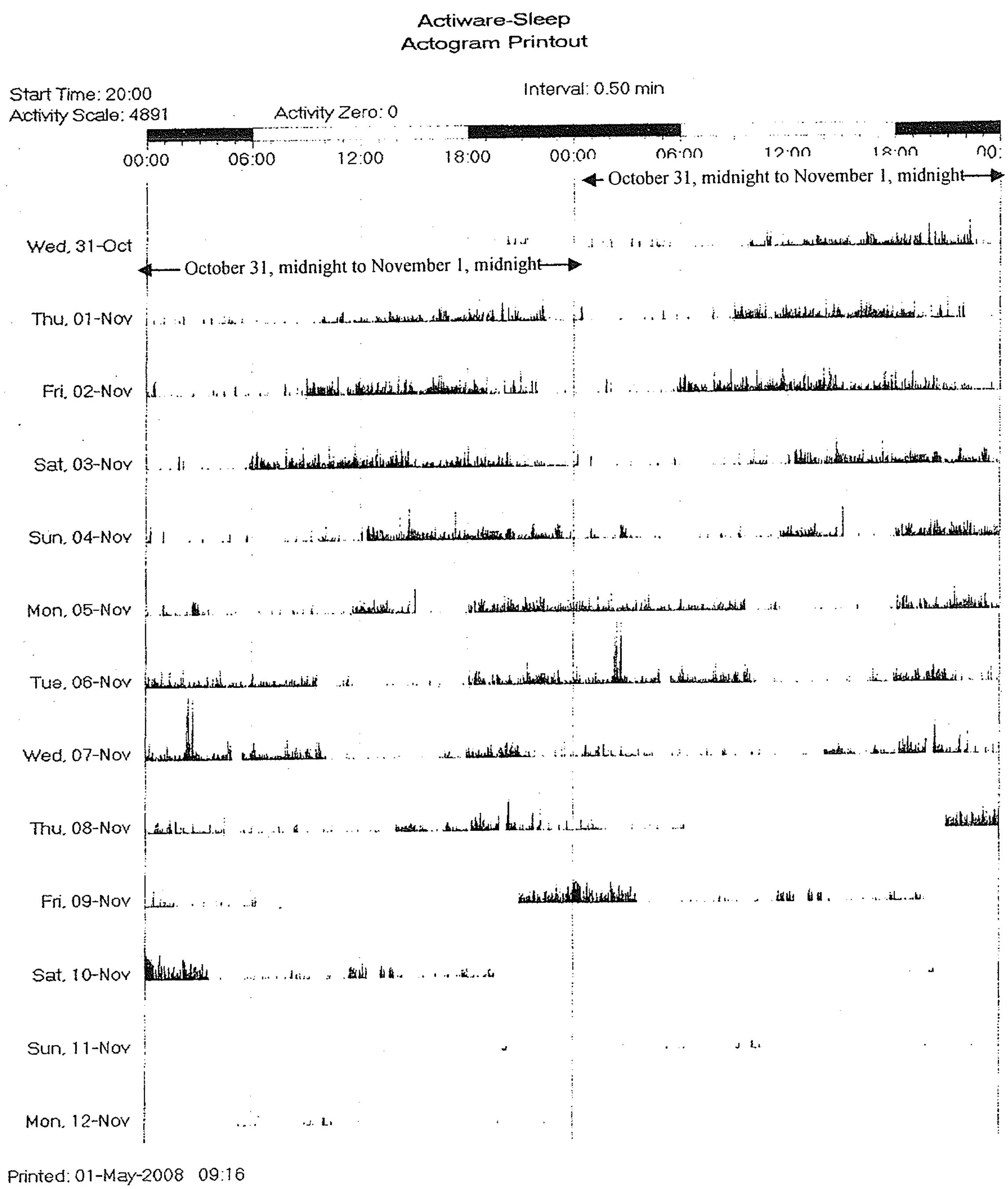


Figure 5.3 Actigraph plot for subject with irregular rest/activity patterns

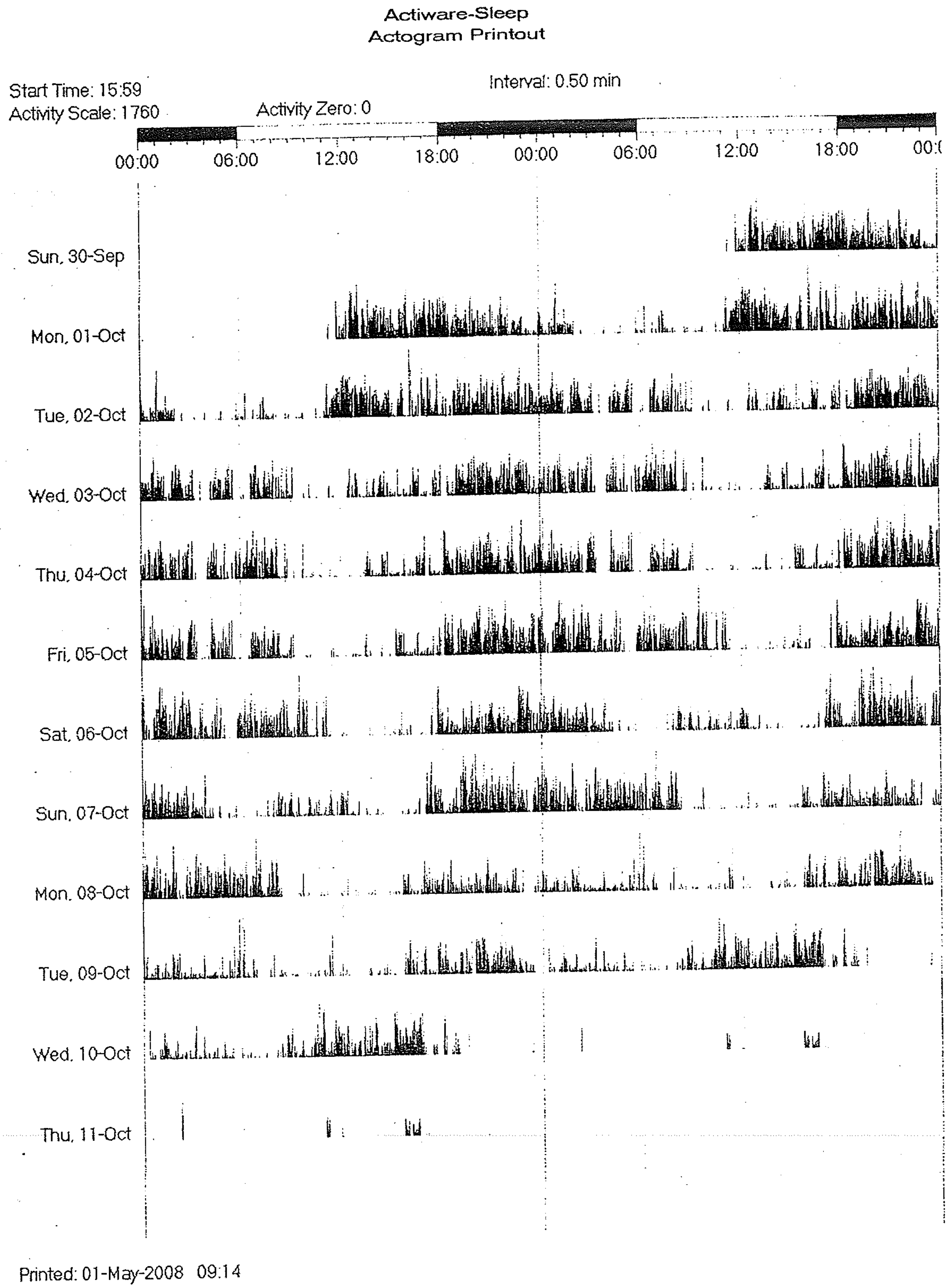
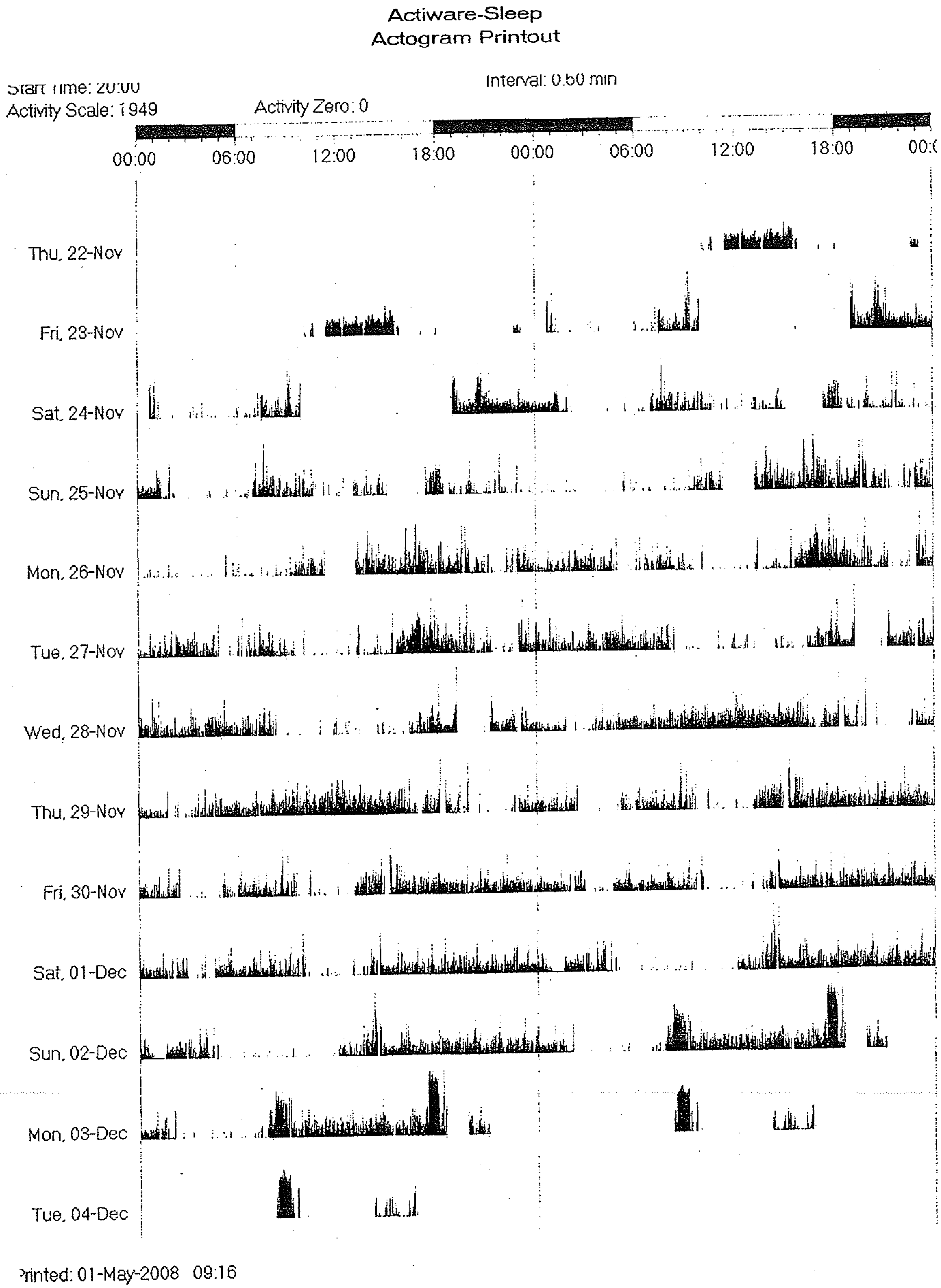


Figure 5.4 Actigraph plot for subject with extremely irregular rest/activity patterns



Research Question Two:

What is the self-reported experience of sleep/wake patterns for critical care nurses engaged in shift work? Is there a difference between work and non-work days?

The purpose of the second question was to describe the nurses' sleep and wake patterns and to examine if there is a difference between working and non-working days. The self-administered Sleep Log was used to measure the critical care nurse's degree of sleepiness and frequency of waking. The Epworth Sleepiness Scale (ESS: Johns, 1991) was utilized to measure the degree of daytime sleepiness experienced by participants.

Nurses were asked to complete the Sleep Log and ESS over 10 days. The days were sorted into "events", in order to compare similar shift and non-shift events against one another. The first and second events were the two days prior to working. These days were labeled Pre-work -2 and Pre-work -1. The first day shift worked was labeled Day 1. The first and second night shifts were labeled Night 1 and Night 2 respectively, and lastly, the first day off after working was called "Day off". These six common "events" were utilized to describe the sleep/wake patterns of the critical care nurses. In addition, the nurses were instructed to complete one extra ESS immediately upon returning home, after finishing their longest stretch of night shifts, and this result is also reported. Two nurses did not work any day shifts and two only worked one night. As a result, 14 subjects' data were included to avoid a list-wise error in analysis of the ESS. One subject did not sleep at all during one 24-hour "event" period. Therefore, only 13 subjects' data was included for the Sleep Log analysis to avoid a list-wise error in analysis of the Sleep Log.

The subjects were asked to rate how well they slept during their last sleep period, on an absolute scale on the Sleep Log. A score of 1 indicates "extremely poor sleep- about the worst I can imagine"; a score of 2 indicates "Poor sleep- I barely rested"; 3 indicates "Fair sleep- some decent stretches, but still less than satisfactory"; 4 indicates "Good sleep- sound and restful, but with minor disturbances"; and 5 indicates an "Excellent sleep- solid and completely restful". The mean scores were calculated to describe the sleep patterns for the group and a single factor repeated measures analysis of variance was undertaken to determine the differences between working and non-working days.

On the Pre-work-2 day, two days prior to working, the average score given was 3.54, indicating a fair-good sleep. On the Pre-work-1 day, the day before working, the average score was 2.85, indicating a poor to fair sleep. On the first day shift of the rotation, the average score was 3.15, indicating a fair sleep and after the first and second night shift, the scores indicated a fair sleep. On the first day off, or restorative day, the mean score was 3.62, which was a fair-good sleep. In the pair-wise comparison between groups, the difference between the Pre-work-1, the day before working, and the first day off was -.769. A pooled, within subject comparison requires that the variance be taken into account, therefore the standard error is .343, and the difference is significant at a level of $p = .05$. The remaining pair-wise comparisons were not significant. Table 5.5 summarizes the self-rated sleep quality identified by the subjects.

Table 5.5 Mean Sleep Log Self-Rating of Sleep Quality by Event

Event	Mean (n=13)	Standard Deviation	Standard Error	Indicator
Pre-Work -2	3.54	.776	.215	Fair Sleep
Pre-Work -1	2.85	.801	.222	Poor Sleep- Fair Sleep
Workday 1	3.15	.899	.249	Fair Sleep
Night 1	3.31	.751	.208	Fair Sleep
Night 2	3.46	.776	.215	Fair Sleep
Day Off	3.62	.961	.266	Fair Sleep- Good Sleep

Subjects were also asked to rate how refreshing and restorative they felt their sleep had been. A score of 1 indicates "Not at all restorative- I derived no benefit from my time in bed" to a score of 5 which indicates "Very satisfactory- feel completely refreshed and ready for the day". On the Pre-work -2 day, the mean score was 3.62, indicating a "restorative, but not adequately so" to "relatively satisfactory" sleep. On the Pre-work -1 day, the mean score was 2.85, "some slight restorative value" to "restorative, but not adequately so". The remainder of the events indicated a "restorative, but not adequately so" sleep. Table 5.6 summarizes the self-reported level of restorative sleep as identified by the subjects.

A single factor repeated measures analysis of variance was conducted and a pair-wise comparison between events, with adjustments for multiple comparisons was made. The results indicated a significant difference between Pre-work -2 and Pre-work -1, with the mean difference 0.769, SE .201, $p = .002$. There was also a significant difference between the Pre-work -2 and the first working day, mean difference .538, SE .243, $p = .047$. There was no significant difference between the other events.

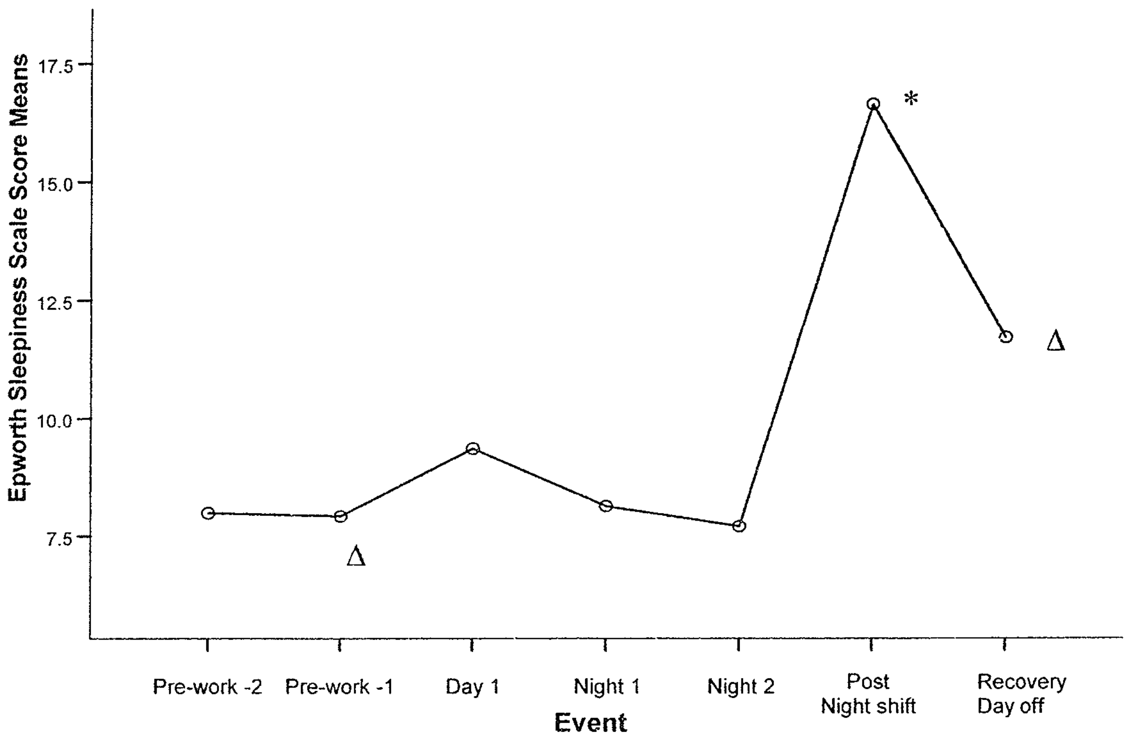
Table 5.6 Mean Sleep Log Self-Rating Scores of Sleep Restoration by Event

Event	Mean (n=13)	Standard Deviation	Standard Error	Indicator
Pre-Work -2	3.62	.768	.213	Restorative-Relatively satisfactory
Pre-Work -1	2.85	1.06	.296	Some slight restorative value
Workday 1	3.08	1.12	.309	Restorative
Night 1	3.54	.877	.243	Restorative-Relatively satisfactory
Night 2	3.31	.855	.237	Restorative
Day Off	3.08	1.12	.309	Restorative

To measure the degree of daytime sleepiness of participants, the ESS scores were analyzed. Two nurses did not work any day shifts and two only worked one night, therefore only 14 of 18 subjects' data were included to avoid a list-wise error in the analysis of the ESS. Using a single factor repeated measures analysis of variance to determine the differences between working and non-working days, testing revealed that the mean ESS score differences between the pre-work days, the day shift and the night shifts were not significant. However, there were differences between the working and pre-work days, and the first day off. To increase the stringency of the comparison between the groups, a Bonferonni correction was applied. A very conservative level of significance was set at $p < .001$ to increase the confidence that the difference between the working and non-working shifts is not accidental. The mean ESS on the Pre-work-2 day was 8.00 (SE ± 1.47, $p = .05$). On work Day 1, the mean ESS score was 9.36 (SE ± 0.99, $p = .05$), but dropped to 7.71 (SE ± 1.33, $p = .05$) after the second night shift. On the first day off, the ESS mean score rose to 11.71 (SE ± 1.58, $p = .05$). The overall mean ESS was 16.64 (SE ± 1.47, $p = .05$) on the immediate return home, before sleeping. Figure

5.5 depicts the difference between the mean ESS scores when compared by events as reported by the critical care nurses.

Figure 5.5 Mean Total Epworth Sleepiness Scale Scores for Work and Non-work Events



Note: *Differences between Post Night Shift and all other events, significant at the .05 level

Δ Differences between Pre-work -1 and Recovery, significant at the .05 level

Additionally, a pairwise comparison between the events revealed significant differences between the ESS score immediately upon return home (post night shift) and every other event, Pre-work -2, Pre-work -1, Dayshift 1, Night 1, Night 2 and recovery day off. Significant differences were also noted between the day before work (Pre-work -1) and the recovery day off and between the recovery day off and the night shifts. These results are depicted in Table 5.7.

Table 5.7 Pairwise Comparison of Epworth Sleepiness Scale Events

Event	Mean Difference (n=14)	Standard Error	Significance[a]
Pre-work -1			
Pre-work -2	-.07	1.05	.947
Workday 1	-1.43	1.12	.220
Night 1	-.22	1.29	.870
Night 2	.22	1.19	.859
Post nightshift	-8.71*	1.32	<.001
Day off	-3.79*	1.38	.016
Post night shift			
Pre-work -2	8.64*	1.75	<.001
Pre-work -1	8.71*	1.31	<.001
Workday 1	7.29*	1.78	.001
Night 1	8.50*	1.29	<.001
Night 2	8.93*	1.52	<.001
Day off	4.93*	1.02	<.001
Day off			
Pre-work -2	3.71	1.84	.065
Pre-work -1	3.79*	1.38	.016
Workday 1	2.36	1.63	.173
Night 1	3.57*	1.45	.029
Night 2	4.00*	1.59	.026
Post nightshift	-4.93*	1.02	< .001

Note: * $p < .05$

a. Adjustments for multiple comparisons: Least significant difference (equivalent to no adjustment)

Research Question Three:

What are the rest/activity patterns of critical care nurses engaged in shift work as measured by actigraphy? Is there a difference in rest/activity patterns between work and non-work days?

To elicit any patterns related to the nurses' rest and activity, the mean scores were calculated for each measure of sleep component. The days were sorted into "events" in order to compare similar shift and non-shift events against one another. The first and second events were the two days prior to working. These days were labeled Pre-work -2 and Pre-work -1. The first day shift worked was labeled Day 1. The first and second night shifts were labeled Night 1 and Night 2, respectively and lastly, the first day off after working was called "Day off". There were two nurses who did not work any day shifts and two who only worked one night. Therefore, to avoid a list-wise error, 14 subjects' data, rather than data from all 18 subjects, were compared. The results in minutes are displayed in Table 5.8. The mean time in bed (TIB) on Pre-work -1, the day before working, was 9.19 hours and on the first day off, the mean TIB was 7.12 hours. The sleep onset latency (SOL) was compared between the pre-work days, days, nights and days off. On the day before working, Pre-work -1, the mean sleep latency, or time to fall asleep, was 28.50 minutes and after the day shift was 19.9 minutes. After the second night shift, the mean sleep latency was 33.07 minutes and on the day off, this dropped to 18.50 minutes. The minutes of wakening after going to sleep were measured and are described as wake after sleep onset (WASO). The mean WASO on the Pre-work -1 was 44.71 minutes. On the first day shift the mean WASO was 35.29 minutes. On the first night shift the WASO was 36.79 minutes and on the day off, the WASO was 33.14

minutes. To describe how efficient the subject's sleep was, the sleep efficiency (SE) is measured using the Actigraphy®. The sleep efficiency calculates the amount of time the subject spends in bed that is actually spent sleeping. On the pre-work -1 day, the mean SE was 79.20% (SD ± 10.96). Day 1 mean SE was 81.11% (SD ± 8.34). The mean SE on the first night off was 78.87% (SD ± 10.65). The mean actual sleep time on the pre-work -1 day was 7.77 hours, (SD ± 174.44 minutes). On the working day, the sleep time was 6.24 hours, (SD ± 84.11 minutes). On the day off after working, the mean sleep time dropped to 5.93 hours, (SD ± 132.09 minutes).

Table 5.8 Mean Actigraphy Scores of Sleep Components by Event

Measure	Prework-1 (±SD)	Day 1 (±SD)	Night 1 (±SD)	Night 2 (±SD)	Day Off (±SD)
Time in bed in minutes (hrs)	551.57 ±127.64 (9.19 ± 2.12)	463.36 ±122.03 (7.72 ± 2.03)	497.93 ±125.84 (8.29 ± 2.09)	495.21 ±109.18 (8.2 ± 1.80)	427.79 ±149.80 (7.12 ± 2.50)
Total sleep time in minutes (hrs)	466.36 ±174.14 (7.77± 2.90)	374.79 ±84.11 (6.24 ± 1.40)	376.43 ±99.14 (6.27± 1.65)	375.86 ±88.21 (6.26 ±1.47)	356.21 ±132.09 (5.93 ± 2.20)
Sleep efficiency (%)	79.20 ±10.96	81.11 ±8.34	76.53 ±8.78	73.62 ±9.44	78.87 ±10.65
Sleep latency in minutes	28.50 ±24.82	19.93 ±16.42	28.14 ±26.86	33.07 ±51.99	18.50 ±13.43
Wake after sleep onset in minutes	44.71 ±24.25	35.29 ±16.07	36.79 ±21.56	46.21 ±39.01	33.14 ±18.55

Note: n = 14

To answer the question of whether there is a difference between work and non-work shifts, a repeated measures analysis of variance was used to analyze the objective actigraphy results and to compare these between working and non-working shifts. There was no significant difference identified in the amount of time in bed, total sleep time, sleep latency, sleep efficiency, and sleep onset between working and non-working days.

It should be noted that there was a mean difference of 124 minutes between the time in bed on Pre-work-1 day and the day off, however, the standard deviation is over 127 minutes. As well, there is a 90 minute mean difference between the total sleep times for these two events, but the standard deviation is greater than 170 minutes.

Research Question Four:

How do the nurses' subjective reports of sleep/wake patterns compare with their objective measures of rest/activity?

The nurses' Sleep Log self reports were compared to the objective measures of the Actigraph to determine to what extent the data from the two instruments are related to each other. The null hypothesis is that there is no relationship between the nurses' Sleep Log and actigraphy measures. To test this hypothesis, the ninth day of data collection was chosen as the day to compare, as there were 6 nurses who worked night shift, 6 who worked days and 6 who were off. This allowed an equal representation of each of the shift options and maximized the variability between shifts, further allowing detection of any correlation.

The information from the Sleep Log and Actigraphy was compared, using a Spearman's rank correlation coefficient (r_s), non-parametric test to identify any significant correlations between the ranks. This correlation calculation was chosen because the correlation assumes that there is a normal distribution between the groups and that the groups are of equal size and the data are ordinal-level; criteria that the data met. The results are presented in Table 5.9.

The sleep efficiency was compared between the Actigraphy® data and the Sleep Log data. Figure 5.6 depicts the correlation between the two instruments. The mean sleep efficiency, as reported on the Sleep Log was 84.99 (SD ± 11.67) and 79.44 (SD ± 7.39) on the actigraph. The relationship between the two instruments with regards to sleep efficiency was weak and non-significant at $r_s = .315$, $p = .203$, two-tailed. This supports the null hypothesis that there is no relationship between the self-reported sleep efficiency that which is measured by actigraphy.

The mean sleep latency (SOL) for the Sleep Log on day 9 was 17.89 minutes (SD ± 23) and by actigraphy was 22.28 minutes (SD ±17.85). The sleep latency, depicted in Figure 5.7, demonstrated a weak positive relationship at $r_s = .409$, $p = .092$, two-tailed, therefore the null hypothesis cannot be rejected as the relationship is not significant.

The minutes awake after falling asleep (WASO) were recorded and compared. The mean WASO on day 9 of the Sleep Log was 29.17 minutes (SD ± 41.27) and 47.39 minutes by actigraphy (SD ± 35.87). This correlation, $r_s = .555$, $p = .017$, two-tailed, indicates with 95% confidence that the nurses' self-reported waking after sleep onset was significantly related to the data recorded by actigraphy (Figure 5.8).

The mean TIB for the Sleep Log is 7.3 hours (SD ± 142.49 minutes) and TIB for actigraph is 7.5 hours (SD ± 141.61 minutes). The time in bed (TIB) between actigraphy and Sleep Log indicated a strong positive correlation at $r_s = .971$, $p = .001$, two-tailed. The nurses' self-reported Sleep Log time in bed was strongly related to the data measured by actigraphy, rejecting the null hypothesis (Figure 5.9).

The mean actual sleep time according to the Sleep Log was 369.06 minutes (SD ±127.59) and 379.83 minutes (SD ±113.14) as measured by actigraphy. The Sleep Log and actigraphy actual sleep time data are considered moderately and positively correlated at $r_s = .560$, $p = .016$, two-tailed, indicating that the nurses' self-reported Sleep Log actual sleep time is positively related to the data measured by actigraphy. This correlation is depicted in Figure 5.10.

Table 5.9 Correlation between Actigraphy and Sleep Log on Day 9 (N = 18)

Component	Instrument	Mean (±SD)	Spearman's Rank Correlation (r_s)	95% Confidence Interval
Sleep Efficiency (SE) (%)	Sleep log	84.99 ± 11.68	.315	.203
	Actigraph	79.44 ± 7.39		
Sleep Latency (SOL) in minutes	Sleep log	17.89 ± 23.00	.409	.092
	Actigraph	22.28 ± 17.85		
Wake after Sleep Onset (WASO) in minutes	Sleep log	29.17 ± 41.27	.555*	.017
	Actigraph	47.39 ± 35.87		
Time in Bed (TIB) in minutes	Sleep log	438.06 ± 142.49 (7.31± 2.37 hours)	.971*	.001
	Actigraph	452.83 ± 141.61 (7.54 ± 2.36 hours)		
Actual Sleep Time (TST) in minutes	Sleep log	369.06 ± 127.95 (6.15 ± 2.13 hours)	.560*	.016
	Actigraph	379.83 ± 113.11 (6.3 ± 1.88 hours)		

Note: **p* < .05, Two-tailed tests

Figure 5.6 Sleep Efficiency Correlation between Day 9 Sleep Log and Actigraphy

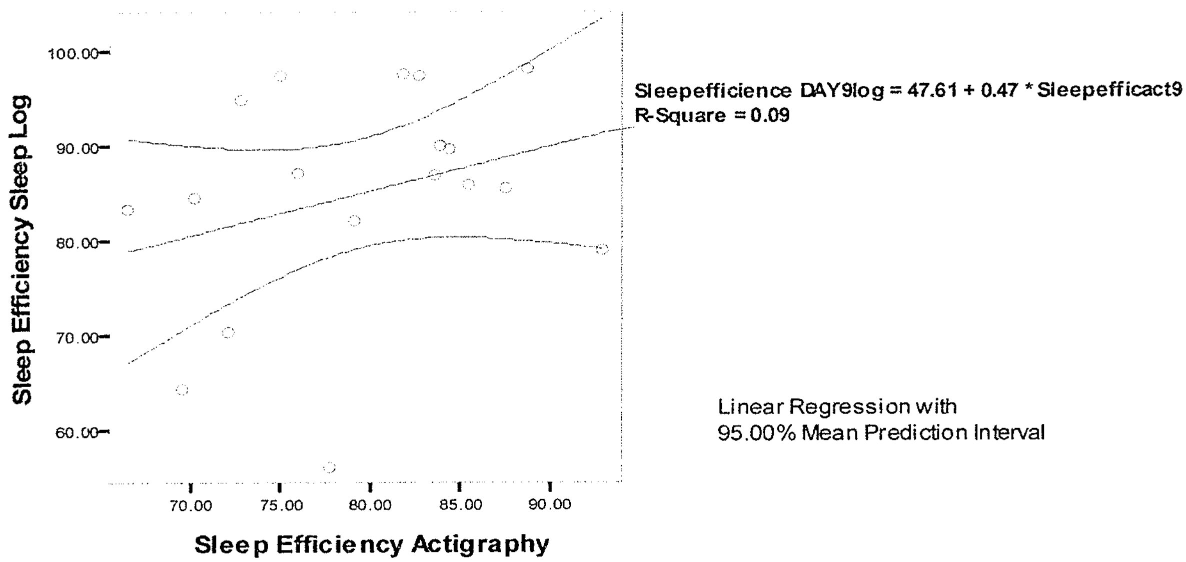


Figure 5.7 Sleep Latency Correlation between Day 9 Sleep Log and Actigraphy

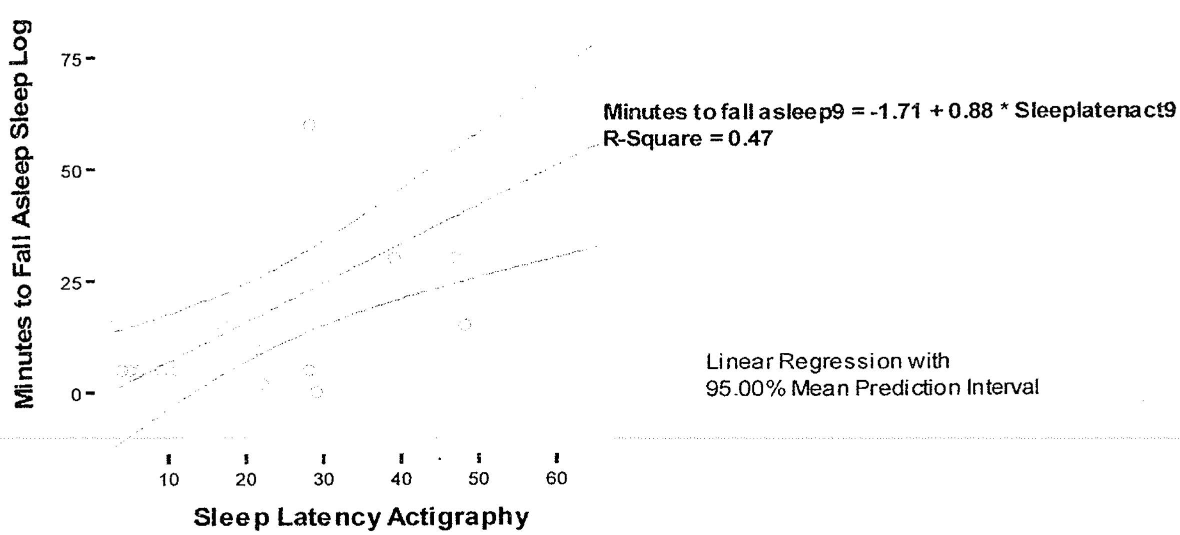


Figure 5.8 Wake After Sleep Onset Correlation between Day 9 Sleep Log and Actigraphy

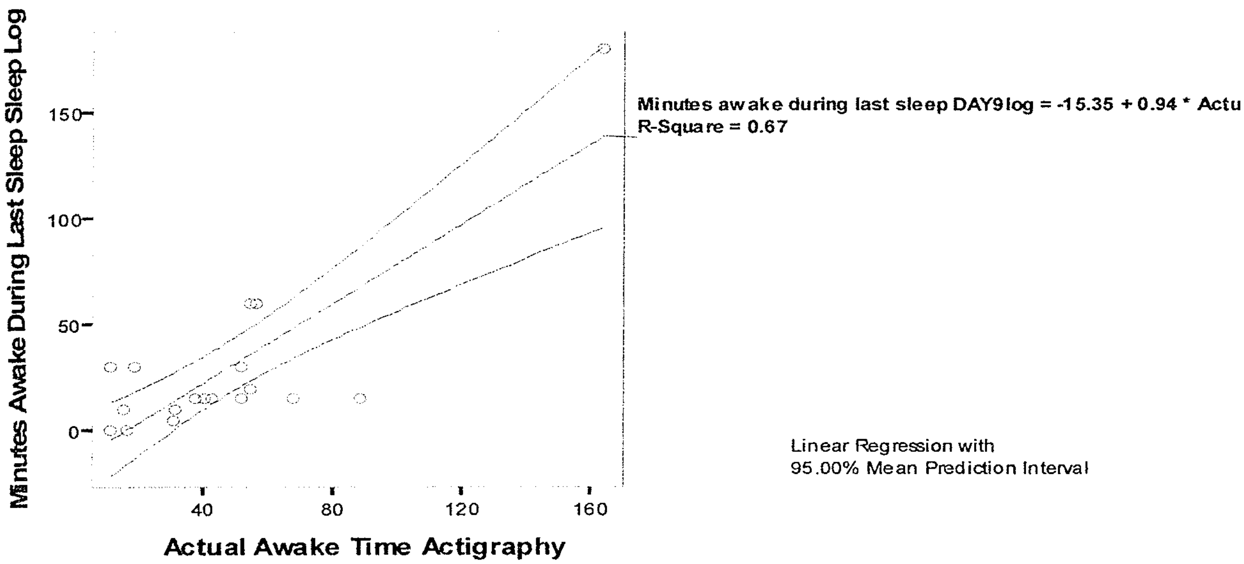


Figure 5.9 Time in Bed Correlation between Day 9 Sleep Log and Actigraphy

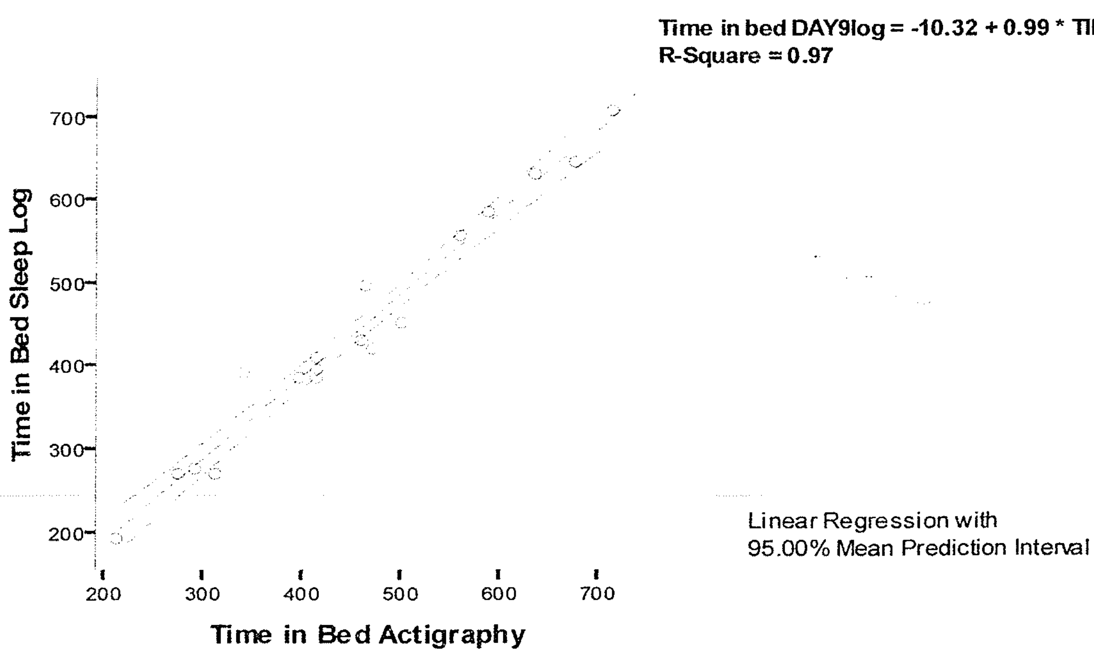
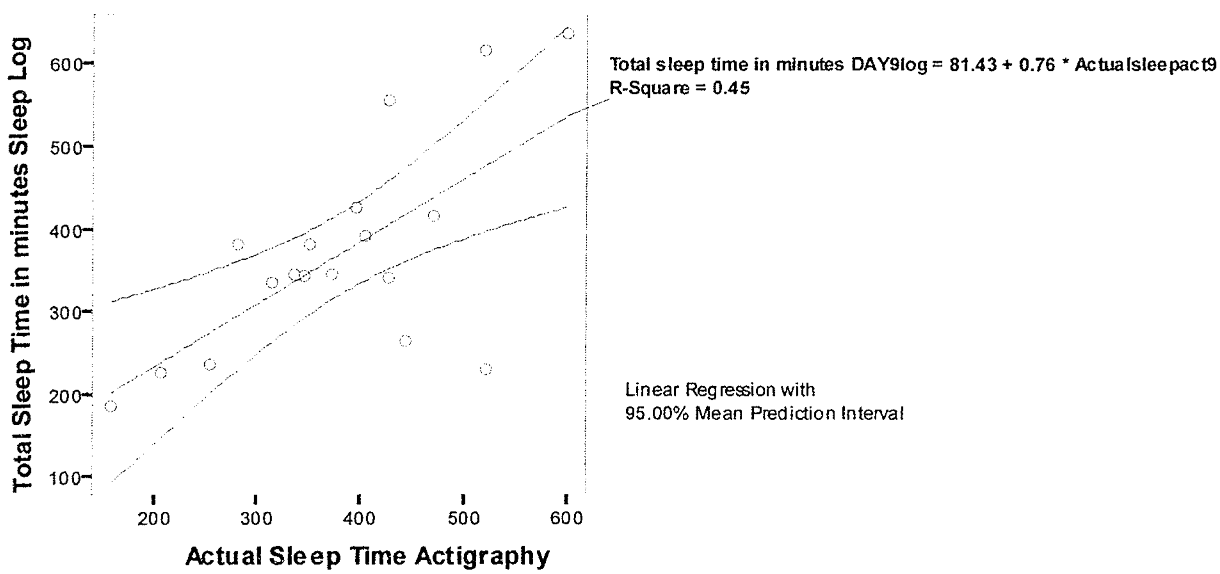


Figure 5.10 Total Sleep Time Correlation between Day 9 Sleep Log and Actigraphy



The results of this non-experimental descriptive correlational pilot study are reported within this chapter. The demographic characteristics of the subjects are presented to provide a description of the critical care nurses who participated in this study. Each of the four research questions was addressed utilizing various data analysis methods and the results of this analysis are provided. Discussion of these findings will be presented in the following chapter.

Chapter 6

Discussion

Within this chapter discussion will focus upon an understanding of the relationship between the type of work schedule critical care nurses practice in, and the effect upon their sleep and wake cycles. This study has captured both the self-reported and objective experiences of critical care nurses who work within a shift work schedule and who facilitated a description of this experience. The use of The Revised Symptom Management Model (Dodd et al., 2001; Larson, et al., 1994) as a framework to guide this study will be briefly described. Demographic data of the subjects will be addressed, followed by a discussion of each of the study questions. The discussion will include the significant findings in the context of the relevant literature and evidence related to the subject of critical care nurses, their sleep and wake patterns, and the impact of such upon the nurses, their patients, and the environment in which they live. Limitations of the study will also be explored, and recommendations for areas of future research are provided. Lastly, a summary of how this research will be disseminated is presented.

The Symptom Management Model

The Revised Symptom Management Model was the framework chosen to guide this study. Chapter 3 provides a detailed description of the model. The intention was to use this model to focus discussion upon the domains of nursing science; the person factors, health and illness, and the environment in which the individuals live. In addition, an understanding of the perception of the symptom experience, and the evaluation and response to symptoms described are framed within the context of this model. Overall, the Revised Symptom Management Model was useful in describing the relationship between the person factors, the risks associated with the experience of shift work and the physical, social and cultural effect upon the environment in which the nurses practice and live. The model also facilitated an understanding of the perception nurses have of these symptoms and their responses, based upon their evaluation. The dynamic nature of the model allowed for the recognition of symptoms and also the recognition that a lack of perception of a symptom does not imply that the individual is experiencing optimal health and well-being or that a symptom does not exist.

In this pilot study, the Domains of Nursing Science were addressed. *Person Domain* included the variables of the person, including their demographic information, such as age, gender, education, and also sociological factors such as the number of dependants. Physiological variables including normal rest and activity patterns, and the risks posed by environmental factors were identified. The assessment of factors that are potentially hazardous to the well being of the individual are conceptualized within the *Health and Illness Domain.* The environmental influences, such as work and home life, beliefs and values, and perception of a symptom experience are captured within the *Environmental Domain.* The Symptom Experience, including the perception of a symptom, how this was evaluated and the response to the evaluation of the symptom was considered. Symptom Strategies were not included as this was beyond the scope of this pilot study. It is difficult to identify the causal nature of the relationship among the variables in this study using this model. However, the Revised Symptom Management Model does allow for the consideration of the multiple variables that may influence the perception of a symptom, as well as an understanding of the factors that influence any strategies that may be developed in the future. Overall, the Revised Symptom

Management Model has not been previously applied to this target group, but in this study, it helps to highlight the complexity of the experience of critical care nurses who work within a rotating shift schedule, the impact upon their sleep and wake patterns, and how this influences their environment, perceptions and strategies.

Demographic Data

According to the Canadian Institute of Health Information (CIHI, 2006), the average age of nurses in Canada is 45 years, with 79% between the ages of 35 and 50 years. The study sample corresponds to the national average as 78% of nurses were between the ages of 31-60 years. Similar to CIHI (2006) data, more critical care nurses in this sample were female than male, although a slightly greater percentage of nurses were male (16.7%) compared with the national average (7.4%). The relatively small number of subjects may account for this discrepancy. This sample of critical care nurses was also better educated than average, with 50.0% of the subjects in this study reporting attainment of a Baccalaureate Degree in Nursing, compared to 27.9% of critical care nurses nationally (CIHI, 2006). Over half (55.6%) of the nurses in this study worked full-time, similar to the CIHI data which reports that 54.5% of nurses worked full-time in Canada in 2005. All subjects worked a day/night rotation. Marquié and Foret (1999) found that those who work shift within the critical care units may do so because they are more junior nurses or because they are experienced and are able to tolerate shift work better than those who have left. Surprisingly, 55.6% of the nurses in this study have worked in the intensive care unit for greater than 5 years, with 33.3% of these working in the ICU for greater than 10 years indicating that they are experienced nurses who may have learned to adapt to shift work. Within this study, 66.7% of the nurses reported being married or living common-law, which is higher than Statistics Canada (2001) reported marriage rate of ~50% among Canadians. Only 33.3% of subjects reported having one or more dependants. However, this is similar to the findings of Folkard, Monk and Lobban (1978), in their classic study, which compared full-time and part-time nurses who worked permanent nights, and found that 36% of the full-time nurses had children living at home. It is possible that those who have many dependants are too busy to participate in a 10-day study or nurses who have many dependents do not work greater than 60% EFT and were therefore excluded from this study.

Despite the relatively small sample size (N = 18), the demographic information reported for the subjects of this pilot study is similar to that of the general Canadian critical care nurse population. However, further investigation with a larger sample size and including community hospital ICUs is warranted to provide a broader and more diverse pool of subjects.

Research Question One:

How Do the Sleep/Wake Patterns of Critical Care Nurses Who are Engaged in Shift Work Compare with Normative Adult Sleep/Wake Patterns?

The critical care nurses who were engaged in shift work demonstrated sleep/wake patterns that were observably poorer than the sleep/wake patterns in the normative adult population. When compared to the normative adult population, the critical care nurses in this study had ESS (Johns, 1991) scores of 8.57 (SD ± 3.77). Recall that in the ESS, scores can range from "0 to 24", with higher scores indicating more severe daytime sleepiness. At least 30% of nurses had clinically significant daytime sleepiness scores of 10 or over on any of the 10 days of data collection and 33% had an overall average score of > 10. Immediately after working night shift, and before sleeping, the average ESS score was 16.57, indicating a high level of daytime sleepiness. Eighty-eight percent of nurses rated their ESS score above the identified cut point of 10 (Johns & Hocking, 1997) after completing their last night shift, indicating that the nurses were able to perceive the symptom of sleepiness.

The quality of sleep was compared to that of the normative adult population using the Pittsburgh Sleep Quality Index (Buysse et al., 1989). Global scores on the PSQI can range from 0-21, with higher scores indicating a poorer quality of sleep. A PSQI global score of > 6 is recommended to differentiate between good sleepers and those who suffer from sleep disturbances (Backhaus, Junghanns, Brooks, Riemann, & Hohagen, 2002). The nurses in this study had mean global scores of 8.42, almost three points higher than the normative adult population who are considered “good sleepers”. One third reported sleep quality scores indicative of good sleepers. The majority (76.7%) had scores indicating their poor sleep.

Critical care nurses in this study reported fewer hours of sleep than the NSF (2005) recommended 7- 9 hours per night. Based on PSQI scores, only one subject reported an average sleep length of 8.5 hours per night. Half of the sample reported an average sleep length or total sleep time (TST) of < 6.5 hours per night and of these, 16.7% (n = 3) slept an average of 5 hours per night. The average total sleep time reported on the Sleep Logs was 6.15 hours and 6.3 hours on actigraphy, similar to previously reported studies of shift workers (Lamond et al., 2003) and well below the hours of recommended sleep.

Sleep latency, or the time it takes to fall asleep, was compared using the PSQI, the Sleep Log, and actigraphy. Based on the PSQI data, half the subjects reported taking between 15-90 minutes to fall asleep and one third reported taking more than 45 minutes. When this data were compared to that from the actigraphy and Sleep Log, the results were similar. The average sleep latency reported using actigraphy was 22.28 minutes, with a range of 11 to 48 minutes. The data collected using the Sleep Log indicated an average sleep latency of 17.89 minutes, and a range of 4.5 to 41.5 minutes. One of the recognized) symptoms of insomnia is sleep latency of ≥ 31 minutes (Hauri & Wisbey, 1992). However, to be truly defined as insomnia, this must occur at least three times per week, for at least six months. Since this study only required data to be collected for 10 days, no conclusions can be drawn regarding insomnia. However, some findings are suggestive of a risk for the same. During the 10 days of data collection, three nurses reported a sleep latency of ≥ 31 minutes, at least 3 times in a seven day week. One subject in particular reported a sleep latency exceeding 31 minutes, five times during the 10 days and reported taking 30 minutes to fall asleep on three other days. This subject appears to be at increased risk for insomnia.

The amount of time asleep versus wakefulness is known as sleep efficiency. In healthy subjects, sleep efficiency ranges between 88-96% of the minutes scored (Sadeh, Sharkey & Carskadon, 1994). In this study, the average sleep efficiency ranged from 78.59% on Actigraphy® to 82.99% on the Sleep Logs, which is similar to sleep efficiency criteria of between 78-82% SE, used to assess patients with insomnia (Hauri & Wisbey, 1992).

The stability of bed and wake times varied greatly between working and non-working shifts. This was measured using the Sleep Timing Questionnaire (Monk, et al., 2003). When the nurses were not working, almost half (44.5%) reported that their wake time varied by up to 4 hours, but when they were working, the wake time varied by up to 30 minutes per day. The amount of variability in bedtime was also worth noting. When working, bedtimes varied by up to one hour for slightly over half (55%) of the subjects, but when they were off, bedtime varied by up to two hours. This suggests that sleep is structured around working shifts but when the nurses have a day-off, they do not have a regular bedtime or wake up time. Often they stay up later and sleep in longer than when they are working. This may be due to the desire to shift their circadian patterns to become more day oriented. After working, the critical care nurses may chose to stay up later to allow for socialization with the non-shift work oriented world. They may sleep in due to fatigue and also because of the ability to sleep later in the morning, compared to days when working required an early morning wake time.

The results suggest that the sleep and wake patterns of critical care nurses who are engaged in shift work is very different from the normative adult population. Persistent failure to recover from acute end of shift fatigue can be expected to be associated with the evolution of maladaptive chronic fatigue traits (Winwood, Winfield, Dawson, & Lushington, 2005), and therefore the critical care nurses in this study are at risk for significant health related symptoms.

Disorganization of sleep/wake patterns does not allow the central circadian pacemaker to adapt adequately and this may cause lapses in vigilance and attention, performance impairment, and reduction in cognitive functioning (Åkerstedt, 2007;

Shechter, James, & Boivin, 2008). Risks to the nurses' health, such as potential risk of breast cancer, gastrointestinal impairment, obesity and effects upon family life must be considered (Coffey, Skipper, & Jung, 1988; Edell-Gustafsson et al., 2002; Gold et al., 1992; Lee, 1992; Lee & Lipscomb, 2003). Risk to the patient related to the nurses' decreased sleep must be investigated further. In addition, attention must be paid to how nurses spend their time off and focus must be given to strengthening nurses' and hospital administration's understanding of the potential risks related to nurses' disrupted sleep/wake schedules.

Research Question Two:

> *What is the self-reported experience of sleep/wake patterns for critical care nurses engaged in shift work? Is there a difference between work and non-work days?*

The overall self-reported pattern that emerged suggests that nurses who are engaged in shift work have a poor to fair sleep, yet report feeling restored after sleeping. On the night prior to working, nurses do not sleep well, but are relatively satisfied with the sleep they had. This sleep prior to working is rated as poor to fair, and is only slightly restorative. During working shifts, their sleep is reportedly fair but restorative. After the first night shift, in spite of being rated as "fair", the sleep is reportedly more satisfactory, than during any other sleep period. The recovery day off shift sleep is fair to good and the nurses report feeling restored. It is surprising to note that despite reporting a poor to fair sleep that the nurses did not perceive this to be troublesome, but rather, felt rested afterward. This may be "that nurses begin to adapt to work with rotating shift patterns"

(Winwood, Winfield & Lushington, 2006, p. 595), and therefore they may have developed adaptive strategies.

Analysis of daytime sleepiness revealed a very distinct pattern in the critical care nurses' sleep/wake cycle depending on the shift worked. Nurses report higher levels of sleepiness after their first day shift, their daytime sleepiness levels dropped during their night shift, but rose significantly, immediately after they had completed a stretch of night shifts prior to sleeping. This suggests that the critical care nurses are experiencing difficulty staying awake between completion of their work shift and prior to going to bed. This is the time when nurses return home from work and likely drive to get home. These results are consistent with the findings of Scott et al. (2007), who found critical care nurses who worked night shifts, were almost four times more likely to have difficulty staying awake when driving home. As pointed out by these researchers, the drive for sleep is greatest during the early morning hours, when nurses are driving home after night shift (Scott et al., 2007). This drowsy driving presents significant risk to the nurse who is driving home, as well as the general public who are utilizing the roads at this time, though the majority of the fatigue-related crashes tend to involve single vehicles (Scott et al., 2007). This is particularly disconcerting in light of studies that indicate that subjects do not have the ability to judge sleep onset because the warning signs, such as head nodding and increased frequency of yawning, are often ignored or may not even happen (Kaplan, Itoi & Dement, 2007).

After sleeping, nurses' self-reported daytime sleepiness scores remained above the standard cut point of 10 on the ESS, indicating that despite sleep, after working a stretch of night shifts, nurses continued to be sleepy. This may be due to an accumulated sleep debt because of limited recovery time between shifts, or because the average amount of sleep is shorter than recommended. In addition, nurses appear to sleep better during their night shifts than during or before their day shifts. This may be, in part, due to the nurses acknowledging the need to sleep after nights, therefore making sleep after nights a priority. However, it appears that during their day shifts or off days, the recovery may be poorer because either the nurses are sleeping in later because they are tired, or they are choosing to wake earlier than recommended in order to shift their sleep cycle to become more oriented to day patterns. Other domestic responsibilities such as child or elder care may also influence their sleep. Working multiple shifts, including night work, has been associated with higher acute work-related fatigue, poorer intershift recovery, and higher maladaptive chronic fatigue (Winwood et al., 2006; Åkerstedt et al., 2002). These factors can potentially impact the long-term health of nurses and must be studied further.

Research Question Three:

> *What are the rest/activity patterns of critical care nurses engaged in shift work as measured by actigraphy? Is there a difference in rest/activity patterns between work and non-work days?*

The Actigraph® was utilized to assess the rest and activity patterns of critical care nurses who were engaged in shift work. The data indicate that prior to working, nurses spent on average, over nine hours in bed, perhaps indicating their intention to be well rested prior to working. However, they only slept for seven hours and it took them almost half an hour to fall asleep. Once they were asleep, they woke up for an average of 44.71 minutes. It appears that the sleep on the night before work is fitful and only

79.20% efficient. Two possible explanations for this include anxiety prior to working, or fear of oversleeping. After the nurses had worked a day shift, it appears that they spent less time in bed, fell asleep more quickly (19.93 ± 16.42 minutes) and more time was spent sleeping. Nonetheless, they only slept an average of slightly over six hours. Their sleep efficiency was slightly better than the pre-work night, at 81.11%, but they still awoke for an average of 35.29 minutes on the night after working days.

Sleep after working nights was similar for both the first and second night. The nurses slept for a mean of 6.27 hours, but spent on average 8.28 hours in bed. Their sleep latency was close to half an hour on each of the nights. On the first night, it took a mean of 28.14 (SD ± 26.86) minutes to fall asleep, but they awoke on average for 36.79 (SD ± 26.86) minutes and their sleep was 76.53% efficient. On the second night it took longer to fall asleep (mean 33.07 ± 51.99 minutes) and the nurses awoke for longer periods (mean 46.21 ± 39.01 minutes).

The recovery day off, the sleep after working night shift, was similar to the other sleep events. The only exception was that it did not take as long to fall asleep. The mean nurses' sleep latency on the day off sleep was 18.50 (SD ± 13.43) minutes. The total sleep time was less than the previous sleep events, as the nurses slept an average of 5.93 hours (SD ± 132.09 minutes). This could again be due to limiting sleep, to facilitate rotation back to that of the general non-shift worker.

It was surprising that there was no statistically significant difference with respect to hours of sleep between working and non-working shifts. Overall, the nurses slept for fewer hours than those recommended by the National Sleep Foundation (2005). This is in keeping with the findings of Rogers (2005) who found that nurses obtain no more sleep than the general public, despite an awareness of the importance of sleep. The sleep was interrupted frequently and was less efficient than that reported by those considered to have insomnia (Hauri & Wisbey, 1992).

These results are of particular concern when considering the risk to the health of the subjects and their patients. Sleep deprivation and shift work related sleep disruptions can result in lapses in vigilance and attention, poorer performance on tasks, and reduced cognitive functioning (Åkerstedt, 2007; Papp et al., 2004). In addition, health effects such as the increased risk of obesity, insulin resistance syndrome, risk of heart attack, stroke, and diabetes are all increased with lower levels of sleep (Schardt, 2005; Spiegel et al., 2004). Despite the lack of variation between working and non-working shifts, the rest and activity patterns of critical care nurses who are engaged in shift work is concerning. The pattern of short, interrupted, fitful sleep, for periods below that which is recommended for healthy individuals, puts these nurses at risk for severe symptoms and potential health and illness outcomes that could affect their overall functional status.

Research Question Four:

How do the nurses' subjective reports of sleep/wake patterns compare with their objective measures of rest/activity?

In opposition to the null hypothesis, that no relationship exists between subjective and objective measures of sleep, the nurses' subjective reports of sleep/wake patterns compared favorably with the objective measures of rest/activity for some variables. The data from the Sleep Log, which measured the subjective sleep/wake patterns, was compared to the objective measures as collected by Actigraphy®. The ninth day of data collection was chosen because complete data were available for each nurse on this day.

In addition, one third of the nurses (n = 6) worked day shift, one third worked night shift and one third were on a day off. This allowed for comparison across shifts and ensured inclusion of all subjects.

It is interesting to note that the critical care nurses in this study overestimated the percent of sleep versus wake time, or sleep efficiency using the Sleep Log compared to the sleep efficiency calculated from the Actigraphy® data: the mean sleep efficiency, as reported on the Sleep Log was 84.99 (SD ± 11.67) and 79.44 (SD ± 7.39) on the Actigraph. The relationship between the two instruments with regards to sleep efficiency was weak and non-significant at $r_s = .315$, $p = .203$, two-tailed. Similarly, they underestimated the amount of time it took them to fall asleep. The mean SOL for the Sleep Log was 17.89 minutes (SD ± 23) and by actigraphy was 22.28 minutes (SD ± 17.85) demonstrating a weak, positive, and non-significant relationship at $r_s = .409$, $p = .092$, two-tailed.

Nurses were asked to estimate the minutes that they were awake during their last sleep period using the Sleep Log. The results indicate a positive correlation between the subjective and objective measures ($r_s = .555$, $p = .017$, two-tailed). The nurses slightly underestimated how many minutes they were awake during their last sleep period when this was compared to the objective measures recorded by Actigraph®. The nurses were able to estimate the actual sleep time. Most significantly, nurses were also able to accurately record the amount of time in bed.

The nurse's ability to accurately record the variables such as wake after sleep onset, actual sleep time, and time in bed is not surprising. The nurses were able to estimate the time they were awake during their sleep period. This may be because they were more aware of how often and for how long they were awake as a result of participating in this study. Familiarity with the data collection tools may have also heightened awareness of sleep and wake times. In terms of actual sleep time, the nurses were able to accurately estimate how long they slept. One reason for this may be the fact that this question is asked after the question about bedtime and sleep latency. Nurses were also asked how many hours they slept. The answers were converted to minutes in order to compare these data with those of the actigraph data. Subjects may have "rounded up" or "rounded down" when estimating hours of sleep, therefore, the actual minutes may be estimated, rather than actual minutes. Though every effort was made to decrease the risk of a Type I error, rejecting the null hypothesis when it is true, it would be more appropriate to record actual sleep time in minutes, should this study be replicated to decrease the risk of error.

The most strongly and positively correlated variable was time in bed. Nurses were asked to record the time they turned out the lights, actually trying to sleep and they were asked to record the time they got out of bed. Both of these questions rely upon nurses looking at the clock and writing the times down. The nurses, by virtue of the data collection requirements for this study, may have become accustomed to noting bed and wake times. Perhaps by the ninth day, they were very confident in recording the times accurately. It is also possible that nurses, as experienced shift workers, are very aware of when they go to bed and wake up, since large amounts of their life are dictated by the clock. Sleep, or lack of sleep may be a perceived symptom and awareness of how much or how little sleep nurses are receiving may be one factor that helps them to evaluate this symptom. The ability to accurately determine the amount of sleep nurses get each night is important from a policy and staffing perspective. The results suggest that nurses are aware of the amount of sleep they are getting. This suggests that they are therefore, accurately able to describe the symptoms that they are experiencing. For example, if nurses state that they are tired, this may, in fact be true.

The findings of the current study indicate that the subjective measures of sleep and wake were not significantly correlated with the objective measures of rest and activity related to sleep efficiency and sleep latency. However the results indicate a positive correlation between the subjective measures of sleep and wake, and the objective rest and activity measures, particularly related to the amount of time nurses are awake during a normal sleep period, the time they spend in bed and the actual amount of sleep they receive. It appears that Sleep Logs are adequate instruments to measure nurses' sleep related to their wake and sleep time and time in bed in clinical settings. The Sleep Logs are more accessible and less expensive than actigraphy, easy to administer and easy for participants to use. The ability to self monitor sleep and wake times is encouraging from a risk management and safety perspective. Nurses' identification of a symptom, such as lack of sleep, will help to develop strategies to manage the symptom or reduce risks to improve outcomes to the person.

Limitations

It is important to consider the limitations that may influence the validity of the results of this study. In addition, consideration of the limitations may help to strengthen and guide future research in this area. Limitations that have been identified are related to the sample, the method of data collection, and the instruments that were utilized for this study.

Sample

A non-probability convenience sample was utilized for this study. According to Polit and Hungler (2004), this form of sampling is less likely to produce accurate and representative samples when compared to probability sampling. The risk, inherent in this form of sampling is that available subjects might not be typical of the population of interest. In an attempt to counter this, inclusion and exclusion criteria were clearly identified. As well, invitations to participate in the study were extended to four intensive care units within a large tertiary care hospital. Nurses from one unit chose, for undisclosed reasons, to not participate. The data collection was only taken from one hospital. A multi-site study, that included both tertiary and community hospital ICU nurses would be helpful in increasing the generalizabilty of the study findings.

Method of Data Collection

The data collection period of two months allowed for 18 subjects to be recruited. Three volunteers were not utilized because of the time constraint and the limited availability of Actigraphy® watches. Each subject was required to wear the Actigraph for a period of 10 days. Ideally, the time between subjects would have been minimal, but due to the fluctuating work schedules, extensive coordination was required to obtain watches from the subjects, download the information, and deliver the newly re-set watches to the next subject. This resulted in occasional time delays that limited the number of subjects who could be recruited. In order to download information from the watches, access to the computer housed in the researcher's supervisor's office was required. This additional coordination further limited the number of subjects who could be recruited within the short data collection period. A longer data collection period and access to a portable computer for downloading information from the actigraphy would potentially increase the sample size and minimize some of these issues. The larger sample size would allow for greater generalizability of the findings from the study.

The majority of nurses who chose to participate in this study did not have dependants or their dependants were, for the most part, adult children. Those with young families, or older dependants did not participate in this study, perhaps due to the many other demands upon their time. However, no conclusive statements can be made about those who chose not to participate as data were not collected from them.

Instruments and Tools

Patient demographic questionnaire

The patient demographic questionnaire was a useful tool in that it provided information related to the person factors, including age, gender, education, sociological and environmental fact. The tool was relatively easy to understand and required little time on the part of the subjects to fill out. Information pertaining to the number of years of marriage, divorce, or being widowed was not utilized as this did not appear to be relevant to this study. As well, the question related to the estimated hours spent on domestic activities required further clarification from the researcher. The choices offered appeared quite broad. Rather than offering options that are divided by hours, choices offered that are divided by minutes would perhaps provide a more meaningful response. A question related to the age and number of dependents and the amount of time spent on domestic factors related specifically to caring for dependents might have yielded richer information.

The Pittsburgh Sleep Quality Index

The PSQI captured information related to the qualitative self-report of sleep quality. This included information related to the time it takes to fall asleep, the quality of the sleep, and estimates of the sleep duration. The global scores helped to identify the quality of sleep and therefore the potential risk for physiologic responses and symptoms that subjects face can be anticipated. However, the tool was cumbersome for some participants. Questions related to reasons for having trouble sleeping were identified, but the data were not utilized as this was beyond the scope of this study. In addition, questions related to having a roommate or bed partner were viewed as intrusive by some subjects, though all chose to answer these questions. Although the information obtained provided a rich data set, this tool did not specifically identify concerns related to shift workers and their rotating schedules.

Epworth Sleepiness Scale

The Epworth Sleepiness Scale was a very useful tool to capture the degree of daytime sleepiness. The tool was easy to use and subjects had no difficulty completing this tool, despite the requirement to fill out the ESS daily, upon wakening. The scoring was also very straightforward. Subjects anecdotally reported that they were interested in the results of this particular tool, as they were able to note the impact their work schedules had upon their scores. The ability to retrospectively estimate the likelihood of sleep in eight specific situations allows for future exploration of the critical care nurses propensity for sleep.

Sleep Timing Questionnaire

This two page questionnaire was chosen to gain an understanding of the subject's habitual sleep timing. Subjects found this instrument difficult to use and hard to understand. Clarification was sought by most subjects. The instructions included a statement "if you worked during the night, think of 'NIGHT' as time of day and 'MORNING' as time of night" and this proved to be particularly difficult to understand as the subjects are shift workers who work both days and nights. The questions related to the stability of bed and wake times were easier to answer, however, many of the categories overlapped. For example, one choice offered was 106-120 minutes; the next category was 2-3 hours, followed by 3-4 hours. Therefore, any clear distinction between categories was lost and this is a flaw in the tool. This instrument is not an appropriate tool to use to describe the sleep and wake patterns of shift workers. It is perhaps more appropriate for subjects who have relatively regular sleep patterns.

Sleep Log

The Mayo Sleep Disorders Centre' Sleep Log (Richardson & Hauri, personal communication, August 31, 2007) was a simple document that subjects were asked to complete on a daily basis. This tool was relatively easy to use, however, it did not allow for the times when subjects did not sleep at all. In addition, some of the data may not be accurate (Buysse et al., 1991), as some subjects may have completed the Sleep Log retrospectively. The Sleep Log did provide information about the subjects' total sleep time, sleep onset latency, and total wake time. It was necessary for the researcher to calculate the time in bed by subtracting bedtime from wake time, which could potentially lead to calculation errors. The calculations were checked three times by the researcher to ensure accuracy. Information related to napping and sleeping medication was not utilized in this study, but has been collected for future study. This tool was useful in providing insight into the subjects' symptom experience, as they were asked to compare the quality and restorative nature of their sleep, thus adding to the richness of the description of their sleep/wake patterns.

Actigraphy

The actigraphy provided a rich data set. The instrument captured the movement of the subjects, allowing the behavior during both day and night to be studied. Total sleep time, wake time, sleep efficiency, latency and wake after sleep onset data were recorded over the 10 day data collection period. Few subjects expressed difficulties using the actigraph after the first day of data collection. The actigraphy data for day one was not utilized because of the variability in start times and variability in time of initializing the watch. Additionally, the researcher had no prior experience with the instrument, apart from literature reports related to the tool, therefore information relayed to the subjects, initially, was unclear. It is recommended that the instrument be worn by the researcher and data downloaded and analyzed as practice, prior to actual data collection in order to fully grasp the instrument's utility.

Some subjects who were not used to wearing anything on their wrists during sleep reported an increased awareness of the Actigraph during the first night of data collection, and felt that their sleep was disturbed until they were comfortable with the watch. In addition, the previously mentioned co-ordination of schedules to retrieve, access and download the watch, the coordination of the next subject's schedule to deliver the watch in a timely manner, and the added burden of co-ordinating shift workers schedules to allow adequate sleep and rest added another logistical dimension that was not anticipated.

Once the information was downloaded, the analysis required more time than initially projected due to the inexperience of the researcher. The initial analysis was confirmed and validated by the supervisor who reviewed the scoring until she was confident in the investigator's ability to adequately mark the actigraph tracings. Despite the complexity of the scheduling, the downloading, and the scoring, this instrument provided a very rich data set and added to the strength of the information gathered.

Future Research

There are many directions future research can take as a result of this pilot research. A larger sample size is necessary to confirm the results of the present study. This would require a longer data collection period and include multiple study sites. The sample should include critical care nurses from both tertiary and community based intensive care units and could be extended to include those who work in the emergency departments as well. Ideally, critical care nurses who have younger families or are caring for older dependents would be recruited to help make the results richer and more generalizable. Additionally, demographic information related to the nurses' health, including Body Mass Index (BMI), exercise, menstrual cycles, eating, alcohol intake and smoking habits could also be explored, to enhance an understanding of the symptom experience of the nurse. As well, information related to strategies used to deal with symptoms could be collected. It would also be beneficial to repeat this study over time. A more longitudinal approach would allow for more diagnostic symptom assessments.

The long term effects of sleep deprivation would be able to be more fully described in this population.

Further exploration related to the Epworth Sleepiness Scale and the nurses' responses may yield information that can help to guide policy changes related to nurses' safe return home after night shifts. The data presented in this study indicated a real risk for a fatigue related motor vehicle crash and identification of strategies to reduce the nurses' risk of adverse events and the risk to self or the public in the future is paramount. The specific situations that indicate the nurses' propensity for sleep will allow for targeted approaches to minimize further risk and improve outcomes for the nurses in the future.

The issue of performance and safety must not be overlooked. Nurses in this pilot study slept fewer hours than that recommended by the National Sleep Foundation (2005). Critical care nurses look after patients who are often clinically unstable and therefore need to be alert to subtle changes in patients' conditions, provide compassionate care to the patients and families, and frequently assess and respond quickly to any changes as needed. Many researchers, including Weinger and Ancoli-Israel (2002) and Gaba et al., (2005), have ascertained that sleep deprivation or sleep disturbances can affect performance and may be an important factor in patient safety. Further research, specifically measuring performance in the critical care nurse population needs to be conducted to determine what, if any effect lack of sleep has upon the performance of the nurse. It is imperative that future research be directed toward ensuring the safety of patients in order to develop policies and safe work practices with the goal of adverse event prevention.

The information gathered using the Sleep Logs related to napping can be analyzed in the future to add to the depth of knowledge related to napping and critical care nurses. This can then be further utilized to develop symptom management strategies and policies related to napping during work hours to offset any potential outcomes that may be related to the symptom status of the nurses.

Development of a symptom assessment tool that is designed specifically for shift workers would help to elicit a better understanding of nurses' sleep/wake patterns. This tool would require strict instructions to avoid any misinterpretation that may occur because of sleep deprivation. As well, provision would need to be made for times when the shift worker does not sleep at all during the 24- hour period. The challenge of developing such a tool is to capture the many dimensions related to working in a rotating shift schedule, while ensuring the tool is easy to complete for the subjects, and easy to score for the researcher.

Though only one nurse reported a period of an absence of sleep for a 24-hour period, it is likely that this is a fairly common occurrence. Additional exploration must take place to determine the prevalence of this event. If nurses are, in fact, working with little to no sleep, there is potential for risk to self and to the patients. The health effects of sleep deprivation, including menstrual irregularity, obesity, heart disease, all impact society as well as the population at large. Further research, over longer periods of time is essential to capture and describe this event.

The research can also be targeted toward the development of education material for nurses who work within critical care environments and work shift. Information related to symptom management strategies such as safe driving, healthy nutritious eating, benefits of exercise, and an understanding of the sleep and circadian rhythms will help to improve outcomes for the nurses, their families and the patients within the intensive care settings.

This quantitative study combined subjective and objective components of sleep/wake and rest/activity. Replication with the addition of a qualitative component to inquire further about the experience of shift work and its' effects upon the sleep/wake patterns of critical care nurses is suggested. Strategies utilized by the nurses and the impact upon their families can also be explored using a qualitative approach to develop a deeper understanding of the experience of shift work upon this population.

Finally, research related to the ideal length of shifts, frequency of rotation and rest periods is also indicated. The use of overtime and rapid rotation from nights to days needs to be further studied and the methodology utilized for this present study appears to be a sound approach by which to explore these variables in more depth. The study by Scott et al. (2007), which described the prevalence of drowsy driving and the relationship between drowsy driving and nurse work hours, alertness on duty, night work and sleep duration, needs to be replicated in this population, with the addition of Actigraphy and the Epworth Sleepiness Scale to augment the strength of the data collected.

Dissemination of Results

The results of this study will be shared with the critical care nurses who participated in this study in the form of a written document and/ or presentation that summarizes the results of this pilot study. Participants who indicated on their informed consent forms that they would like a summary of the research findings will be mailed a summarized document. The results of this thesis research will be submitted for publication in appropriate nursing or sleep journals such as *Dynamics; the Official Journal of the Canadian Association of Critical Care Nurses* or *Sleep*. Abstracts will also be submitted for presentation of a research paper at local and national nursing conferences that highlight critical care nursing or sleep research. Finally, a presentation of the research paper will be offered to the nurses who work at the tertiary care hospital where the study was conducted during their Nursing Grand Rounds.

Summary

The purpose of this pilot study was to describe the sleep/wake patterns of critical care nurses who work shift using both the nurses' self reports to obtain a subjective perspective and actigraphy to obtain an objective measure. The overall aim of this study was to describe the relationship between the type of work schedule critical care nurses practice in, and the effect upon their sleep and wake cycles. The Revised Symptom Management Model was chosen to guide the research.

Critical care nurses who were engaged in shift work demonstrated sleep/wake patterns that were observably different from the sleep/wake patterns in the normative adult population. The nurses in this study slept for shorter periods of time, and took longer to fall asleep than the normative adult population. Nurses appear to sleep better during their night shifts than during, or before their day shifts. On the days that they are working, nurses' bed and wake times were very stable, but on their days off, nurses went to bed later than normal and slept in later than when they were working. There was a positive correlation between the subjective measures of sleep and wake, and the objective rest and activity measures, particularly related to the amount of time nurses are awake during a normal sleep period, the time they spend in bed, and the actual amount of sleep they receive. Nurses were also able to identify situations that indicated they were sleepy, particularly on the drive home after a night shift, where they were at high risk of falling asleep.

This study provides fertile information to help to guide future research. A number of questions and areas of further inquiry have been highlighted by this pilot study. Attention must be paid to the development of policies related to patient and nurse safety, particularly related to the potential risks associated with sleep deprivation and shift workers. Education related to critical care nurses and their sleep/wake patterns may help to offset potential risk to both the nurse and the patients for whom they care. The results of this study serve to highlight the need for continued research in the area of sleep and its' effect upon critical care nurses. Further exploration into the health effects, effects upon the performance of the nurses and effects upon the domestic factors related to sleep must continue and remain a priority to ensure the safety of all those who are living and working within the healthcare system.

References

Aiken, L.H., Clarke, S.P., Cheung, R.B., Sloane, D.M., & Silber, J.H. (2003). Education levels of hospital nurses and mortality of surgical patients. *JAMA, 290* (12), 1617-1623.

Åkerstedt, T. (2003). Shift work and disturbed sleep/wakefulness. *Occupational Medicine, 53,* 89-94.

Åkerstedt, T. (2007). Altered sleep/wake patterns and mental performance. *Physiologic Behavior, 90,* 2-3, 209-218.

Åkerstedt, T., & Gillberg, M. (1990). Subjective and objective sleepiness in the active individual. *International Journal of Neurosciences, 52*, 29-37.

Åkerstedt, T., & Knutsson, A. (1989). Coping strategies used by nurses on night duty. *Ergonomics, 29*, 185-196.

Åkerstedt, T., Knutsson, A., Westerholm, P., Theorell, T., Alfredsson, L., & Kecklund, G. (2002). Sleep disturbances, work stress and work hours. A cross-sectional study. *Journal of Psychosomatic Research, 53*, 741-748.

American Association of Critical Care Nurses. (2006). Available at: www.aacn.org/AACN/mrkt.nsf/vwdoc/AboutCriticalCareNursing. Accessed November 22, 2006.

Armstrong, T.S. (2003). Symptoms experience: A concept analysis. *Oncology Nursing Forum, 30*(4), 601-606.

Arnedt, J.T., Owens, J., Crouch, M., Stahl, J., & Carskadon, M.A. (2005). Neurobehavioral performance of residents after heavy night call vs after alcohol ingestion. *JAMA, 294*(9), 1025-1033.

Ancoli-Israel, S. (2000). Actigraphy. In M.G. Kryger, T. Roth & W.C. Dement (Eds.), *Principles and Practices in Sleep Medicine* (4th ed., pp. 1295-1301). Philadelphia: W.B. Saunders.

Ancoli-Israel, S., Cole, R., Alessi, C., Chanbers, M., Moorcroft, W., & Pollock, C.P. (2003). The role of actigraphy in the study of sleep and circadian rhythms. *Sleep, 26*(3), 342-392.

Axelsson, J., Åkerstedt, T., Kecklund, G., & Lowden, A. (2004). Tolerance to shift work how does it relate to sleep and wakefulness? *International Archives of Occupational Environmental Health, 77*, 121-129.

Backhaus, J., Junghanns, K., Broocks, A., Riemann, D., & Hohagen, F. (2002). Test-retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. *Journal of Psychosomatic Research, 53*, 737-740.

Barton, J., Spelten, E., Totterdell, P., Smith, L., Folkard, S., & Costa, G. (1995). The Standard Shiftwork Index: A battery of questionnaires for assessing shiftwork-related problems. *Work and Stress, 9*, 4-30.

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Manual for the Beck Depression Inventory-II.* San Antonio, Tx.: Psychological Corporation.

Beersma, D.G.M., & Gordijn, M.C.M. (2007). Circadian control of the sleep-wake cycle, *Physiology & Behavior, 90*(2-3), 190-195.

Blachowicz, E., & Letizia, M. (2006). The challenges of shift work. *MedSurg Nursing, 15*(5), 274-280.

Bonnefond, A., Muzet, A., Winter-Dill, A.S., Bailloeuil, C., Bitouze, F., & Bonneau, A. (2001). Innovative working schedule: Introducing one short nap during the night shift. *Ergonomics, 44*(10), 937-945.

Bonnet, M.H. (1985). Effect of Sleep Disruption on Sleep, Performance, and Mood. *Sleep, 8*(1), 11-19.

Bonnet, M.H. (2005). Sleep Deprivation. In M.G. Kryger, T. Roth & W.C. Dement (Eds.), *Principles and Practices in Sleep Medicine* (4th ed., pp. 51-66). Philadelphia: W.B. Saunders.

Bonnet M.H., & Arand, D.L. (1998). Arousal components which differentiate the MWT from the MSLT. *Sleep, 21,* 477-484.

Budnick, L.D., Lerman, S.E., Baker, T.L., Jones, H., & Czeisler, C.A. (1994). Sleep and alertness in a 12-hour rotating shift work environment. *Journal of Occupational Medicine, 36*, 1295-1300.

Buysse, D.J., Reynolds, C.F., Monk, T.H., Hoch, C.C., Yeager, A.L., & Kupfer, D.J. (1991). Quantification of subjective sleep quality in healthy elderly men and women using the Pittsburgh Sleep Quality Index (PSQI). *Sleep 14*(4), 331-338.

Buysse, D.J., Reynolds, C.F., Monk, T.H., Berman, S.R., & Kupfer, D.J. (1989). The Pittsburgh sleep quality index: A new instrument. *Psychiatry Research, 28*(2), 193-213.

Canadian Association of Critical Care Nurses. (2003). Mission Statement. www.caccn.ca. Downloaded July 14, 2003.

Canadian Institute for Health Information Statistics. (2006). Workforce Trends of Registered Nurses in Canada. Registered Nurses Database. www.cihi.ca/nurses. Downloaded November 26, 2006.

Canadian Nurses Association. (2005). RN workforce profiles by area of responsibility year 2005. Canadian Nurses Association Department of Public Policy. www.cna-aiic.ca. Downloaded November 26, 2006.

Carskadon, M.A., & Dement, W.C. (2005). Normal Human Sleep. In M.G. Kryger, T. Roth & W.C. Dement (Eds.), *Principles and Practices in Sleep Medicine* (3rd ed. pp. 13-23). Philadelphia: W.B. Saunders.

Charloux, A., Gronfier, C., Chapotot, F., Ehrhart, J., Piquard, F., & Brandenberger, G. (2001). Sleep deprivation blunts the nighttime increase in aldosterone release in humans. *Journal of Sleep Research, 10*, 27-33.

Cheek, R. E., Shaver, J.L., & Lentz, M.J. (2004). Variations in sleep hygiene practices of women with and without insomnia. *Research in Nursing and Health, 27*(4), 225-236.

Chervin, R.D., Aldrich, M.S., Pickett, R., & Guilleminault, C. (1997). Comparison of the results of the Epworth Sleepiness Scale and the Multiple Sleep Latency Test. *Journal of Psychosomatic Research, 42*(2), 145-155.

Clissold, G., Smith, P., Accutt, B., & Di Milia, L. (2002). A study of female nurses combining partner and parent roles with working a continuous three-shift roster: The impact on sleep, fatigue and stress. *Contemporary Nurse, 12*(3), 294-302.

Coffey, L.C., Skipper, J.K., & Jung, F.D. (1988). Nurses and shift work: Effects on job performance and job-related stress. *Journal of Advanced Nursing, 13*(2), 245-253.

Costa, G. (1997). The problem: Shiftwork. *Chronobiology International, 14*(2), 89-98.

Dean, G.E., Scott, L.D., & Rogers, A.E. (2006). Infants at risk: when nurse fatigue jeopardizes quality care. *Advances in Neonatal Care, 6*(3), 120-126.

Demerouti, E., Geurts, S.A., Bakker, A.B., & Euwema, M. (2004). The impact of shiftwork on work--home conflict, job attitudes and health. *Ergonomics, 47*(9), 987-1002.

Dingley, J. (1996). A computer-aided comparative study of progressive alertness changes in nurses working two different night-shift rotas. *Journal of Advanced Nursing, 23,* 1247-1253.

Dijk, D.J., Neri, D.F., Wyatt, J.K., Ronda, J.M., Riel, E., Ritz-de Cecco, A., et al. (2001). Sleep, performance, circadian rhythms, and light-dark cycles during two space shuttle flights. *American Journal of Physiological Regulatory Integrative Comprehensive Physiology, 281,* R1647-R1664.

Dodd, M., Janson, S., Facione, N., Faucett, J., Froelicher, E.S., Humphreys, J., et al. (2001). Advancing the science of symptom management. *Journal of Advanced Nursing, 33*(5), 668-676.

Doi, Y., Minowa, M., Uchiyama, M., Okawa, M., Kim, K., Shibui, K., et al. (2000). Psychometric assessment of subjective sleep quality using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) in psychiatric disordered and control subjects. *Psychiatry Research, 97*(2-3), 165-172.

Dorrian, J., Lamond, N., Holmes, A.L., Burgess, H.J., Roach, G.D., Fletcher, A., et al. (2003). The ability to self-monitor performance during a week of simulated night shifts. *Sleep, 26*(7), 871-877.

Dracup, K., & Bryan-Brown, C.W. (2000). To work: Perchance to sleep. *American Journal of Critical Care, 9*(4), 224-226.

Drummond, S.P.A., Gillin, J.C., & Brown, G.G. (2001). Increased cerebral response during a divided attention task following sleep deprivation. *Journal of Sleep Research, 10*, 85-92.

Edell-Gustafsson, U.M. (2002). Sleep quality and responses to insufficient sleep in women on different work shifts. *Journal of Clinical Nursing, 11*, 280-288.

Edinger, J.D., Marsh, G.R., McCall, W.W., Erwin, C.W., & Lininger, A.W. (1991). Sleep variability across consecutive nights of home monitoring in older mixed DIMS patients. *Sleep, 14*(1), 13-17.

Edwards, A., & Edwards, R. (Eds). (2002). *The Winston Canadian Dictionary* (Revised). Toronto: Harcourt Canada.

Engle-Friedman, M., Riela, S., Golan, R., Ventuneac, A.M., Davis, C.M., Jefferson, A.D., et al. (2003). The effect of sleep loss on next day effort. *Journal of Sleep Research, 12*(2), *113-124.*

Fawcett, J., & Gigliotti, E. (2001). Using conceptual models of nursing to guide nursing research: The case of the Neuman systems model. *Nursing Science Quarterly, 14*(4) 339-345.

Fichten, C.S., Creti, L., Amsel, R., Brender, W., Weinstein, N., Rothenberg, P., et al. (1995). Poor sleepers who do not complain of insomnia: Myths, and realities about psychological and lifestyle characteristics of older good and poor sleepers. *Journal of Behavioral Medicine, 18*(2), 189-223.

Fitzpatrick, J.M., While, A E., & Roberts, J.D. (1999). Shift work and its impact upon nurse performance: Current knowledge and research issues. *Journal of Advanced Nursing, 29*(1), 18-27.

Folkard, S., Monk, T.H., & Lobban, M.C. (1978). Short and long-term adjustment of circadian rhythms in "permanent" night nurses. *Ergonomics, 21*, 785-799.

Friedman, L., Benson, K., Noda, A., Zarcone, V., Wicks, D.A., O' Connell, K., et al. (2000). An actigraphic comparison of sleep restriction and sleep hygiene treatments for insomnia in older adults. *Journal of Geriatric Psychiatry and Neurology, 13*(1), 17-27.

Gaba, D.M., & Howard, S.K. (2002). Fatigue among clinicians and the safety of patients. *New England Journal of Medicine, 347*(16), 1249-1255.

Gold, D.R., Rogacz, S., Bock, N., Tosteson, T.D., Baum, T.M., Speizer, F.E., et al. (1992). Rotating shift work, sleep and accidents related to sleepiness in hospital nurses. *American Journal of Public Health, 82*(7), 1011-1014.

Hakki Onen, S., Alloui, A., Gross, A., Eschallier, A., & Dubray, C. (2001). The effects of total sleep deprivation, selective sleep interruption and sleep recovery on pain tolerance thresholds in healthy subjects. *Journal of Sleep Research, 10*, 35-42.

Harrington, J.M. (2001). Health effects of shift work and extended hours of work. *Occupational Environmental Medicine, 58*, 68-72.

Hauri, P.J., & Wisbey, J. (1992). Wrist actigraphy in insomnia. *Sleep, 15*(4), 293-310.

Hennig, J., Kieferdorf, P., Moritz, C., Huwe, S., & Netter, P. (1998). Changes in cortisol secretion during shiftwork: implications for tolerance to shiftwork? *Ergonomics, 41*(5), 610-621.

Hughes, R.G., & Rogers, A.E. (2004). First, do no harm. Are you tired? Sleep deprivation compromises nurses' health- and jeopardizes patients. *American Journal of Nursing, 104*(3), 36-38.

Hughes, R. & Stone, P. (2004). The perils of shift work: Evening shift, night shift, and rotating shifts: Are they for you? *American Journal of Nursing, 104*(9), 60-63.

Hugonnet, S., Chevrolet, J., & Pittet, D. (2007). The effect of workload on infection risk in critically ill patients. *Critical Care Medicine, 35*(1), 76-81.

Iber, C., Ancoli-Israel, S., Chesson, A.L, & Quan, S.F. (2007). The AASM manual for the scoring of sleep and associated events: Rules, terminology and technical specifications. *AASM Manual for Scoring Sleep.* (1st ed., pp. 24-31). Westchester,Il: American Academy of Sleep Medicine.

Inoue, K., Kakehashi, Y., Oomori, S., & Koizumi, A. (2004). Biochemical hypoglycemia in female nurses during clinical shift work. *Research in Nursing & Health, 27*(2), 87-96.

Johns, M.W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep, 14*(6), 540-545.

Johns, M.W., & Hocking, B. (1997) Excessive Daytime Sleepiness. Daytime Sleepiness and Sleep Habits of Australian Workers. *Sleep, 20*(10), 844-849.

Kaplan, K.A., Itoi, A., & Dement, W.C. (2007). Awareness of sleepiness and ability to predict sleep onset: Can drivers avoid falling asleep at the wheel? *Sleep Medicine, 9*, 71-78.

Kemper, M. (2001). The role and effectiveness of napping on the work performances of shift workers. *Work, 16,* 153-157.

Kivimäki, M., Kuisma, P., Virtanen, M., & Elovainio, M. (2001). Does shift work lead to poorer health habits? A comparison between women who had always done shift work with those who had never done shift work. *Work and Stress, 15*(1), 3-13.

Klien, D.C., Morre, R.Y., & Reppert, S.M. (1991). *Suprachiasmatic Nucleus: the Mind's Clock.* New York: Oxford University Press.

Knuth, P., & Härmä, M. (1992). The relation of shift work tolerance to the circadian adjustment. *Chronobiology International, 9*(1), 46-54.

Kobayashi, F., Furui, H., Akamatsu, Y., Watanabe, T., & Horibe, H. (1997). Changes in psycho-physiological functions during night shift in nurses. Influence of changing from full-day to half-day work shift before night duty. *International Archives of Occupational Environmental Health, 69*, 83-90.

Labyak, S., Lava, S., Turek, F., & Zee, P. (2002). Effects of shiftwork on sleep and menstrual function in nurses. *Health Care for Women International, 23,* 703-714.

Lack, L.C., Mercer, J.D., & Wright, H. (1996). Circadian rhythms of early morning awakening insomniacs. *Journal of Sleep Research, 5*(4), 211-219.

Lamond, N., Dorrian, J., Roach, G., McCulloch, K., Holmes, A.L., Burgess, H.J., et al. (2003). The impact of a week of simulated night work on sleep, circadian phase, and performance. *Occupational and Environmental Medicine, 60*(11), 13.

Landis, C. (2002). Sleep and methods of assessment. *Nursing Clinics of North America, 37*, 583-597.

Landrigan, C.P., Rothschild, J.M., Cronin, J.W., Kaushal, R., Burdick, E., Katz, J.T., et al. (2004). Effect of reducing interns' work hours on serious medical errors in intensive care units. *The New England Journal of Medicine, 351*(18), 1838-1848.

Larson, P.J., Carrieri-Kolhman, V., Dodd, M.J., Douglas, M., Faucett, J., Froelicher, E., et al. (1994). A model of symptom management. *Image. Journal of Nursing Scholarship, 26*, 272-276.

Learhart, S. (2000). Health effects of internal rotation of shifts. *Nursing Standard, 14(*47).

Lee, K.A. (1992). Self reported sleep disorders in employed women. *Sleep, 15*(6), 493-498.

Lee, K.A. (1997). An overview of sleep and common sleep problems. *ANNA Journal, 24*(6), 614-627.

Lee, K.A., Landis, C., Chasens, E.R., Dowling, G., Merritt, S., Parker, K.P., et al. (2004). Sleep and chronobiology: Recommendations for nursing education. *Nursing Outlook, 52*(3), 126-133.

Lee, K.A., & Lipscomb, J. (2003). Sleep among shiftworkers-A priority for clinical practice and research in occupational health nursing. *AAOHN, 51*(10), 418-424.

Libman, E., Fichten, C. S., Bailes, S., & Amsel, R. (2000). Sleep questionnaire versus sleep diary: Which measurement is better? *International Journal of Rehabilitation and Health, 5*(3), 205-209.

Lichstein, K.L., Durrence, H.H., Taylor, D.J., Bush, A.J., & Riedel, B.W. (2003). Quantitative criteria for insomnia. *Behavior and Research Therapy, 41*, 427-445.

Lockley, S.W., Cronin, J.W., Evans, E.E., Cade, B.E., Lee, C.J., Landrigan, C.P., et al. (2004). Effect of reducing interns' weekly work hours on sleep and attentional failures. *The New England Journal of Medicine, 351*(18), 1829-1837.

Marquié, J.C., & Foret, J. (1999). Sleep, age, and shiftwork experience. *Journal of Sleep Research, 8,* 297-304.

Marriner-Tomey, A. (1994). *Nursing Theorists and Their Work* (3rd ed. pp. 4, 10) St. Louis, MO.: Mosby.

Mohren, D.C.L., Jansen, N.W.H., Kant, I., Galama, J.M.D., van den Brandt, P.A., & Swaen, G.M.H. (2002). Prevalence of common infections among employees in different work schedules. *Journal of Occupational Environmental Medicine, 44*(11), 1003-1011.

Monk, T.H. (2005). Shift Work. In M.G. Kryger, T. Roth & W.C. Dement (Eds.), *Principles and Practices in Sleep Medicine.* (4th ed., pp. 673-679). Philadelphia: W.B. Saunders.

Monk, T.H., Buysse, D.J., Kennedy, K.S., Potts, J.M., DeGrazia, J.M., & Miewald, J.M. (2003). Measuring sleep habits without using a diary: The Sleep Timing Questionnaire. *Sleep, 26*(2), 208-215.

Moore, R.Y. (1997). Circadian rhythms: Basic neurobiology and clinical applications. *Annual Reviews Journal, 48*, 253-266.

Muecke, S. (2005). Effects of rotating night shift: Literature review. *Journal of Advanced Nursing, 50*(4), 433-439.

Murata, K., Yano, E., & Shinozaki, T. (1999). Cardiovascular dysfunction due to shiftwork. *Journal of Occupational and Environmental Medicine, 41*(9), 748-753.

Muzet, A., Nicolas, A., Tassi, P., Dewasmes, G., & Bonneau, A. (1995). Implementation of napping in industry and the problem of sleep inertia. *Journal of Sleep Research, 4*(Suppl. 2), 67- 69.

National Sleep Foundation (2005). Available at: http://www.sleepfoundation.org. Accessed July 15, 2006.

Novak, R.D., & Auvil-Novak, S.E. (1996). Focus group evaluation of night nurse shiftwork difficulties and coping strategies. *Chronobiology International, 13*(6), 457- 463.

Papp, K.K., Stoller, E.P., Sage, P., Aikens, J.E., Owend, J., Avidan, A., et al. (2004). The effects of sleep loss and fatigue on resident-physicians: A multi-institutional mixed-method study. *Academic Medicine, 79*(5), 394-406.

Parkes, K.R. (1999). Shiftwork, job type, and the work environment as joint predictors of health-related outcomes. *Journal of Occupational Health Psychology, 4*(3), 256-68.

Perkins, L. (2001). Is the night shift worth the risk? *RN, 64*(8), 65-66, 68.

Philip, P., Taillard, J., Sagaspre, P., Valtat, C., Sanchez-Ortuno, M., Moore, N., et al. (2004). Age, performance and sleep deprivation. *Journal of Sleep Research, 13,* 105-110.

Pilcher, J.J., & Huffcutt, A.I. (1996). Effects of sleep deprivation on performance: A meta-analysis. *Sleep, 19*(4), 318-326.

Pilcher, J.J., Pury, C.L. & Muth, E.R. (2003). Assessing subjective daytime sleepiness: An internal state versus behavior approach. *Behavioral Medicine, 29*(2), 60-67.

Poissonnet, C.M., & Veron, M. (2000). Health effects of work schedules in healthcare professions. *Journal of Clinical Nursing, 9*, 13-23.

Polit, D.F., & Beck, C. (2004). *Nursing Research: Principles and Methods* (7th ed.). Philadelphia: Lippincott.

Polit, D.F., & Hungler, B.P. (1999). *Nursing Research: Principles and Methods* (6th ed.). Philadelphia: Lippincott.

Portela, L.F., Rotenberg.L, & Waissmann, W. (2004). Self-reported health and sleep complaints among nursing personnel working under 12 h night and day shifts. *Chronobiology International, 21*(6), 859-870.

Prontis-Ruotolo, D. (2001). Surviving the night shift. *American Journal of Nursing, 101*(7), 63-68.

Redeker, N. S., Ruggiero, J., & Hedges, C. (2004). Patterns and predictors of sleep pattern disturbance after cardiac surgery. *Research in Nursing and Health, 27*(4), 217-224.

Reid, K., & Dawson, D. (2001). Comparing performance on a simulated 12 hour shift rotation in young and older subjects. *Occupational and Environmental Medicine, 58*(1), 58-62

Revell, V.L., & Eastman, C.I. (2005). How to trick mother nature into letting you fly around or stay up all night. *Journal of Biologic Rhythms, 20*, 353-365.

Rietveld, W.J. (1992). The suprachiasmatic nucleus and other pacemekers. In Y. Touitou & E. Haus (Eds.) *Biologic rhythms in clinical and laboratory medicine.* Berlin, Germany: Springer-Verlag.

Roehrs, T., Carskadon, M.A., Dement, W.C., & Roth, T. (2005). Daytime Sleepiness and Alertness. In M.G. Kryger, T. Roth & W.C. Dement (Eds.). *Principles and Practices in Sleep Medicine* (4th ed., pp. 39-50). Philadelphia: W.B. Saunders.

Rogers, A.E. (2002). Sleep deprivation and the ED night shift. *Journal of Emergency Nursing, 28*(5), 469-470.

Rogers, A.E., Caruso, C.C., & Aldrich, M.S. (1993). Reliability of sleep diaries for assessment of sleep/wake patterns. *Nursing Research, 42*(6), 368-372.

Rogers, A.E, Hwang, W.T, Scott, L.D., Aiken, L.H., & Dinges, D.F. (2004). The working hours of hospital staff nurses and patient safety. *Health Affairs, 23*, 202-212.

Rollinson, D.C., Rahtlev, N.K., Moss, M., Killiany, R., Sassower, K.C., Auerbach, S., et al. (2003). The effect of consecutive night shifts on neuropsychological performance of interns in the emergency department: A pilot study. *Annals of Emergency Medicine, 41*(3), 400-406.

Rosa, R.R. (1995). Extended workshifts and excessive fatigue. *Journal of Sleep Research, 4* (S2), 51-56.

Rose, M., Ware, J., Kolm, P., & Risser, M. (2000). Residual effects of call on sleep and mood in medical residents. *Sleep, 23*, A252-A254.

Ruggiero, J. S. (2003). Correlates of fatigue in critical care nurses. *Research in Nursing & Health, 26,* 434-444.

Sadeh, A., Sharkey, K., & Carskadon, M.A. (1994). Activity-based sleep-wake identification; An empirical test of methodological issues. *Sleep, 17*(3), 201-207.

Sallinen, M., Härmä, M., Mutanen, P., Ranta, R., Virkkala, J., & Müller, K. (2003). Sleep-wake rhythm in an irregular shift system. *Journal of Sleep Research, 12*, 103-112.

Schardt, D. (2005). How sleep affects your weight. *Nutrition Action Healthletter, 7*, 10-11.

Schernhammer, E.S., Laden, F., Speizer, F.E., Willett, W.C., Hunter, D.J., Kawachi, I., et al. (2001). Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. *Journal of the National Cancer Institute, 93*(20), 1563-1568.

Schernhammer, E.S., Laden, F., Speizer, F.E., Willett, W.C., Hunter, D.J., Kawachi, I., et al. (2003). Night-shift work and risk of colorectal cancer in the nurses' health study. *Journal of the National Cancer Institute, 95*(11), 825-828.

Scott, L.D., Hwang, W. T., Rogers, A.E., Nysse, T., Dean, G.E. & Dingers, D.F. (2007). The relationship between nurse works schedules, sleep duration, and drowsy driving. *Sleep, 30*(12), 1801-1807.

Scott, L.D., Rogers, A.E., Hwang, W.T., & Zhang, Y. (2006). Effects of critical care nurses' work hours on vigilance and patients' safety. *American Journal of Critical Care, 15*(1), 30-37.

Shechter, A., James, F.O., & Boivin, D.B. (2008). Circadian rhythms and shift working women. *Sleep Medicine Clinics, 3,* 13-24.

Shields, M. (2002). Shift work and health. *Health Reports, 13*(4), 11-31.

Siegal, J. (2001). The REM sleep-memory consolidation hypothesis. *Science, 294*, 1058-1063.

Smith, C. S., Robie, C., Folkard, S., Barton, J., Macdonald, I., Smith, L., et al. (1999). A process model of shiftwork and health. *Journal of Occupational Health Psychology, 4*(3), 207-218.

Smith, L., Folkard, S., Tucker, P., & Macdonald, I. (1998). Workshift duration: a review comparing eight hour and 12 hour systems. *Occupational Environmental Medicine, 55*(4), 217-219.

Smith, L., Tanigawa, T., Takahashi, M., Mutou, K., Tachibana, N., Kage, Y., & Iso, H. (2005). Shiftwork locus of control, situational and behavioural effects on sleepiness and fatigue in shiftworkers. *Industrial Health, 43*, 151-170.

Spiegel, K., Tasali, E., Penev, P., & Van Cauter, E. (2004). Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Annals of Internal Medicine, 141*(11), 846-850.

Statistics Canada (2001). Available at: http://www.statcan.ca/start.html. Accessed February 7, 2008.

Stokowski, L.A. (2004). A wake-up call for nurses: Sleep loss, safety and health. Available at: http://www.medscape.com/viewarticle/481189. Accessed September 15, 2006.

Sveinsdóttir, H. (2006). Self-assessed quality of sleep, occupational health, working environment, illness experience and job satisfaction of female nurses working different combination of shifts. *Scandinavian Journal of Caring Sciences, 20*, 229-237.

Tenkanen, L., Sjoblom, T., Kalimo, R., Alikoski, T., & Harma, M. (1997). Shift work, occupation, and coronary heart disease over 6 years of follow-up in the Helsinki Heart Study. *Scandinavian Journal of Work, Environment and Health, 23*(4), 257-265.

Tepas, D.I., Duchon, J.C., & Gersten, A.H. (1993). Shiftwork and the older worker. *Experimental Aging Research, 19,* 295-320.

Todd, C., Reid, N., & Robinson, G. (1989). The quality of nursing care on wards working eight and twelve hour shifts: a repeated measures study using the MONITOR index of quality of care. *International Journal of Nursing Studies, 26*(4), 359-368.

Touitou,Y., Motohashi, Y., Reinberg, A., Touitou, C., Bourdeleau, P., Bogdan A., & Auzeby, A. (1990). Effect of shift work on the night-time secretory patterns of melatonin, prolactin, cortisol and testosterone. *European Journal of Applied Physiology, 60,* 288-292.

Trinkoff, A., Geiger-Brown, J., Brady, B., Lipscomb, J., & Muntaner, C. (2006). How long and how much are nurses now working? *American Journal of Nursing, 106*(4), 60-71.

Trinkoff, A.M., Storr, C.L., & Lipscomb, J.A. (2001). Physically demanding work and inadequate sleep, pain medication use, and absenteeism in registered nurses. *Journal of Occupational Environmental Medicine, 43*(4), 355-363.

Trinkoff, A.M., & Storr, C.L. (1998). Work schedule characteristics and substance use in nurses. *American Journal of Internal Medicine, 34*(3), 266-271.

Vitaterna, M.H., Takahashi, J.S., & Turek, F.W. (2001). Overview of circadian rhythms. *Alcohol Research & Health, 25*(2), 85-93.

Weinger, M.B., & Ancoli-Israel, S. (2002). Sleep deprivation and clinical performance. *Journal of the American Medical Association, 287*(8), 955-957.

Wilson, J. L. (2002). The impact of shift patterns on healthcare professionals. *Journal of Nursing Management, 10,* 211-219.

Williams, G., Chaboyer, W., Thornsteindottir, R., Fullbrook, P., Shelton, C., Chan, D., & Wojner, A. (2001). Worldwide overview of critical care nursing organizations and their activities. *International Nursing Review, 48*, 208-217.

Winwood, P.C., Winefield, A.H., Dawson, D.& Lushington, K. (2005). Development and validation of a scale to measure work-related fatigue and recovery: The Occupational Fatigue Exhaustion Recovery Scale (OFER). *Journal of Occupational and Environmental Medicine, 47*(6), 594-606.

Winwood, P.C., Winefield, A.H., & Lushington, K. (2006). Work-related fatigue and recovery: the contribution of age, domestic responsibilities and shiftwork. *Nursing and Healthcare Management and Policy, 56*(4), 438-449.

Yamasaki, F., Schwartz, J.E., Gerber, L.M., Warren, K., & Pickering, T.G. (1998). Impact of shift work and race/ethnicity on the diurnal rhythm of blood pressure and catecholamines. *Hypertension, 32*, 417-423.

Zeman, A., & Reading, P. (2005). The science of sleep. *Clinical Medicine, 5*(2), 97-101.

Zhu, J., Hjollund, N., & Olsen, J. (2004). Shift work, duration of pregnancy, and birth weight: The National Birth Cohort in Denmark. *American Journal of Obstetrics and Gynecology, 191*(1), 285-291.

Appendix A

Subject No. ___________

Demographic Data Form

** Please circle numbered item that is applicable to you.

1. Age

01	21- 30 years of age
02	31- 40 years of age
03	41- 50 years of age
04	51-60 years of age
05	>60 years of age

2. Gender

01	Female
02	Male

3. Years of experience as a registered nurse

01	6months- 5 years
02	>5 years- 10 years
03	>10 years- 15 years
04	>15 years – 20 years
05	> 20 years

4. Years of experience as a critical care nurse

01	6months- 5 years
02	>5 years- 10 years
03	>10 years- 15 years
04	>15 years – 20 years
05	> 20 years

5. What is your occupational equivalent to full-time status?

01	Full-time
02	0.9
03	0.8
04	0.7
05	0.6

6. What is your normal work rotation?

01	Day/ Night
02	Night

7. What is the highest level of schooling or education?
   01 College/ Diploma Program
   02 Baccalaureate in Nursing
   03 Baccalaureate in other than Nursing
   04 Graduate level (Masters or PhD)

8. Do you have certification in your specialty?
   01 Yes
   02 No

9. Did you take an advanced course in your specialty?
   01 Yes
   02 No

10. Marital status
    01 Single/ Never Married
    02 Married/ Common Law
    How long? Years______ Months______
    03 Divorced/ Separated
    How long? Years______ Months_______
    04 Widowed
    How long? Years______ Months_______

11. Age of dependents
    01 <1-5 years
    How many in this category?____
    02 6-10 years
    How many in this category?____
    03 11-15 years
    How many in this category?____
    04 16-20 years
    How many in this category?____
    05 21-50 years
    How many in this category?____
    06 >50 years
    How many in this category?____

12. Estimated number of hours spent on Domestic Factors during an average 24 hour period
    01 0-4 hours
    02 4-8 hours
    03 8-12 hours
    04 12-16 hours
    05 >16 hours

Appendix B

Pittsburgh Sleep Quality Index (PSQI)

Name____________ ID__________ Date__________ Age_________

Instructions:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, when have you usually gone to bed at night?
   USUAL BED TIME__________

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
   NUMBER OF MINUTES_________

3. During the past month, when have you usually gotten up in the morning?
   USUAL GETTING UP TIME__________

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)
   HOURS OF SLEEP PER NIGHT__________

For each of the remaining questions, check the one best response. Please answer *all* questions.

5. During the past month, how often have you had trouble sleeping because you....

(a) Cannot get to sleep within 30 minutes

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(b) Wake in the middle of the night or early morning

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(c) Have to get up to use the bathroom

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(d) Cannot breathe comfortably

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(e) Cough or snore loudly

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(f) Feel too cold

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(g) Feel too hot

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(h) Had bad dreams

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(i) Have pain

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(j) Other reason(s), please describe ____

____

How often during the past month have you had trouble sleeping because of this?

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

6. During the past month, how would you rate your sleep quality overall?

Very good__________
Fairly good__________
Fairly bad __________
Very bad ___________

7. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

10. Do you have a bed partner or roommate?
    No bed partner or roommate___________
    Partner/roommate in other room__________
    Partner in same room, but not same bed __________
    Partner in same bed __________

If you have a roommate or bed partner, ask him/her how often in the past month you have had…..

(a) Loud snoring

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(b) Long pauses between breathes while asleep

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(c) Legs twitching or jerking while you sleep

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(d) Episodes of disorientation or confusion during sleep

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

(e) Other restlessness while you sleep; please describe

Not during the Past month___	Less than once a week___	Once or twice a week___	Three or more times a week___

Appendix C

Epworth Sleepiness Scale

How likely are you to doze off or fall asleep in the following situations in contrast to just feeling tired? Even if you have not done some of these things recently, try to work out how they would have affected you. Use the following scale to choose the most appropriate number for each situation.

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

SITUATION	CHANCE OF DOZING			
Sitting and reading	0	1	2	3
Watching TV	0	1	2	3
Sitting inactive in a public place (eg. A theatre or meeting)	0	1	2	3
As a passenger in a car for an hour without a break	0	1	2	3
Lying down to rest in the afternoon when circumstances permit	0	1	2	3
Sitting and talking to someone	0	1	2	3
Sitting quietly after lunch without alcohol	0	1	2	3
In a car, while stopped for a few minutes in traffic	0	1	2	3

Johns, M.W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep, 14*(6), 540-545.

Appendix D

Mayo Sleep Disorders Centre Sleep Log
Sleep Log

Please fill out this sleep log every day about 30 minutes after getting up. Guess the approximate times; do not worry if your times are not absolutely correct. We are interested in your opinion of how you slept.

Date:	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Did you take naps yesterday? If yes, give total length of sleep in minutes.					
Did you take any sleeping medications? (give time and amount)					
When did you turn out lights, actually trying to sleep?					
How many minutes did it take you to fall asleep?					
How many minutes were you awake during last sleep period? (Do not count the time it took you to fall asleep initially)					
How often did you awaken during your last sleep period?					
How many hours did you sleep last sleep period?					
When did you wake up for the last time after this last sleep period?					
When did you get out of bed for the last time after this last sleep period?					
Compared with your own average over the last month, how well did you sleep during your last sleep period? Choose from list **A** below					
On an absolute scale, how well did you sleep during your last sleep period? Choose from list **B** below					
Overall, how refreshing and restorative was your sleep? Choose one from list **C** below					

A	B	C
1. Much worse than my average	1. Extremely poor sleep---about the worst I can imagine	1. Not at all restorative— I derived no benefit from my time in bed
2. Slightly worse than my average	2. Poor sleep---I barely rested	2. Some slight restorative value
3. Fairly typical for me	3. Fair sleep—some decent stretches, but sill less than satisfactory	3. Restorative, but not adequately so
4. Slightly better than average	4. Good sleep—sound and restful, but with minor disturbances	4. Relatively satisfactory
5. Much better than my average	5. Excellent sleep—solid and completely restful	5. Very satisfactory—feel completely refreshed and ready for the day

Reprinted with permission from Dr. J. Richardson and Dr. P. Hauri, the Mayo Sleep Disorders Centre, 2007.

Appendix E

Sleep Timing Questionnaire

This questionnaire asks about when you normally sleep. We are interested in getting as accurate a picture as we can of the times when you normally go to bed and get up. Please think carefully before giving your answers and be as accurate and as specific as you can be. **Please answer in terms of a recent "normal average week", not one in which you traveled, vacationed or had family crises. Thank you.**

Please think of a GOOD NIGHT TIME as the time at which you are finally in bed and trying to fall asleep. (if you worked during the night, think of "NIGHT" as time of day and "MORNING" as time of night)

On the night before a work day or school day
What is your **earliest** GOOD NIGHT TIME? ___:___pm/am
On the night before a work day or school day
What is your **latest** GOOD NIGHT TIME? ___:___pm/am
On the night before a work day or school day
What is your **usual** GOOD NIGHT TIME? ___:___pm/am

How stable (similar each night) are your GOOD NIGHT TIMES before a work day or school day? *(Circle one)*

0-15 minutes	16-30 minutes	31-45 minutes	46-60 minutes
61-75 minutes	76-90 minutes	91-105 minutes	106-120 minutes
2-3 hrs	3-4 hrs	over 4 hours	

On a night before a day off
What is your **earliest** GOOD NIGHT TIME? ___:___pm/am
On a night before a day off
What is your **latest** GOOD NIGHT TIME? ___:___pm/am
On a night before a day off
What is your **usual** GOOD NIGHT TIME? ___:___pm/am

How stable (similar each night) are your GOOD NIGHT TIMES before a day off day? *(Circle one)*

0-15 minutes	16-30 minutes	31-45 minutes	46-60 minutes
61-75 minutes	76-90 minutes	91-105 minutes	106-120 minutes
2-3 hrs	3-4 hrs	over 4 hours	

Please think of GOOD MORNING TIME as the time at which you finally get out of bed and start your day.

Before a work day or school day
What is your **earliest** GOOD MORNING TIME? ___:___pm/am
Before a work day or school day
What is your **latest** GOOD MORNING TIME? ___:___pm/am
Before a work day or school day
What is your **usual** GOOD MORNING TIME? ___:___pm/am

How stable (similar each night) are your GOOD MORNING TIMES before a work day or school day? *(Circle one)*

0-15 minutes	16-30 minutes	31-45 minutes	46-60 minutes
61-75 minutes	76-90 minutes	91-105 minutes	106-120 minutes
2-3 hrs	3-4 hrs	over 4 hours	

On a night before a day off
What is your **earliest** GOOD MORNING TIME? ___:___pm/am
On a night before a day off
What is your **latest** GOOD MORNING TIME? ___:___pm/am
On a night before a day off
What is your **usual** GOOD MORNING TIME? ___:___pm/am

How stable (similar each night) are your GOOD MORNING TIMES before a day off day? *(Circle one)*

0-15 minutes	16-30 minutes	31-45 minutes	46-60 minutes
61-75 minutes	76-90 minutes	91-105 minutes	106-120 minutes
2-3 hrs	3-4 hrs	over 4 hours	

These questions are about how much sleep you lose to unwanted wakefulness:

On most nights, how long, on average does it take you to fall asleep after you start trying?
_________minutes.

On most nights, how much sleep do you lose, on average, from waking up during the night (eg. to go to the bathroom)? _________minutes.

 Monk,

Buysse, D.J., Reynolds, C.F., Monk, T.H., Berman, S.R., & Kupfer, D.F. (1989). The Pittsburgh sleep quality index: A new instrument. *Psychiatry Research, 28*(2), 193-213.

Appendix F

860 Elm Street

July 26, 2007

Ms. Karen Shaw-Allan
Department of Research
MS7 Thorlakson Building
Health Sciences Centre

Dear Ms Shaw-Allan

Subject: IMPACT Approval Submission

I am a Masters of Nursing Student from the Faculty of Nursing at the University of Manitoba. My thesis chair is **Dr. Diana McMillan, RN, Ph.D.** I am submitting this package to the H.S.C. Research Impact Committee (RIC) to apply for impact approval.

The intention of this pilot study is to develop an understanding of the sleep/wake patterns of critical care nurses who work shift. Therefore, the subjects of interest are critical care nurses who work in one of four critical care units within the largest teaching hospital in Winnipeg. All the nurses are educated and competent adults who are able to consent freely to participate in this study.

I am enclosing three copies of the impact approval form, a summary of the study protocol, a copy of all of the research instruments and all supplementary material that will be given to the subjects.

I look forward to hearing from you soon,

Respectfully,

Asha A. Pereira
Masters of Nursing Student

Enclosures:

- Summary of study protocol (13 pages)
- Research instruments:
  - Demographic questionnaire (Appendix A),
  - Pittsburgh Sleep Quality Index (PSQI) (Appendix B),
  - Epworth Sleepiness Scale (ESS) (Appendix C),
  - Daily Sleep Log (Appendix D),
  - Sleep timing questionnaire (STQ) (Appendix E),
  - Actigraph information sheet (1 page)
- E-mail from manufacturer (2 pages)
- Recruitment Poster (1 page)

Appendix G

September 10, 2007

To: Dr. Stan Straw, Chair
Education/Nursing Research Ethics Board (ENREB)

From: Asha A. Pereira
Principal Investigator

Re: Protocol #E2007:064
"Sleep/Wake Patterns of Critical Care Nurses: A Pilot Study"

Thank you for the letter dated August 27, 2007. I will address each of your three concerns below.

1. I have revised the consent form and indicated that the research is for a Master's degree program. I am *not* an employee of nor do I have any supervisory role related to any of the intensive care units (ICUs) involved in the study, so have not added this piece. I am currently employed as a Clinical Nurse Specialist with the Acute Pain Service at the Health Sciences Centre. (Appendix A).

2. In order to recruit nurses for the study, I intend to meet with each of the Managers of Patient Care for each of the selected ICUs to find out from them the best way to contact their staff; specifically, a staff or program meeting, and or posted flyers. Dependent on manager feedback, I will arrange to attend a staff meeting or program team meeting where a description of the proposed study will be presented and nurses will be invited to participate and my contact information will be provided. The other approach involves that I will post a flyer on an approved location, with my contact information on the units and any nurse who is interested in volunteering will contact me. At this time, we will arrange to meet in order to confirm participation and address any questions. Once informed consent has been obtained, I will provide the subjects with the questionnaires, envelop of instructions and Actigraph® watch. (Appendix B).

3. Please find enclosed all the copyright permissions that have been obtained. It was my error in writing "redrawn" on the tools, as they were essentially just "retyped". Please see amended tools (Appendix C). In addition, I have included the copyright permission to use the Revised Symptom Management Model (Appendix D) and letters of support from the Directors of the ICUs and the Vice President of Nursing at Health Sciences Centre (Appendix E).

I look forward to you response. Thank you.
Asha Pereira, MN Student

Appendix H

APPROVAL CERTIFICATE

12 September 2007

TO: **Asha A. Pereira** (Advisor Dr. McMillan)
Principal Investigator

FROM: **Stan Straw, Chair**
Education/Nursing Research Ethics Board (ENREB)

Re: **Protocol #E2007:064**
"Sleep/Wake Patterns of Critical Care Nurses: A Pilot Study"

Please be advised that your above-referenced protocol has received human ethics approval by the **Education/Nursing Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement. This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- if you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to Kathryn Bartmanovich, Research Grants & Contract Services (fax 261-0325), including the Sponsor name, before your account can be opened.

- if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/ors/ethics/ors_ethics_human_REB_forms_guidelines.html) **in order to be in compliance with Tri-Council Guidelines.**

Appendix I

Health Sciences Centre
Winnipeg

Office of the Director of Research

Dial Direct 204-787-2404
Fax 204-787-4547

September 19, 2007

Ms Asha A. Pereira
Principal Investigator
860 Elm Street, Winnipeg MB R3M 3P5

Dear Ms Pereira

RE: THE SLEEP-WAKE PATTERNS OF CRITICAL CARE NURSES: A PILOT STUDY.

ETHICS #: E2007:064 RIC #: RI07:108

The above-named protocol, **has been evaluated and approved** by the HSC Research Impact Committee.

The Department of Research wishes you much success with your study.

Sincerely

Karen Shaw-Allan
Research Protocol Officer
Health Sciences Centre

cc: Director of Research
Ancillary Services, Finance Division

Appendix J

HEALTH SCIENCES CENTRE
Arthritis Centre
RR149-800 Sherbrook Street
Winnipeg, MB, Canada
R3A 1M4

(204) 787-1851 (HSC Office)
(204) 787-4594 (Fax)
(204) 787-2392 (Appointments)

Department of Medicine
Dr H El-Gabalawy, Director
Dr C Peschken
Dr D Robinson
Dr C Hitchon

Department of Pediatrics and Child Health
Dr K Oen
(204) 787-2020

September 25, 2007

Nurse Asha A. Pereira
860 Elm Street
WINNIPEG, MB
R3M 3P5

Dear Ms. Pereira:

Re: Research protocol RI07:108 "The sleep/wake patterns of critical care nurses: A pilot study."

The Pediatric Research Coordinating Committee met on September 17, 2007 and approval of this study has been granted provided Ethics approval has been obtained and the study is not done during working hours.

Please inform the Pediatric Research Coordinating Committee of the dates data collection is started and completed (at time of completion).

Yours truly,

Kiem G. Oen, MD, FRCPC
Chairperson
Pediatric Research Coordinating Committee

KGO:jc

c.c. File
Karen Shaw
S. Fogg, RN, MN, Director of Patient Services
Dr. D. McMillan, RN, PhD, Academic Advisor

Appendix K

Health Sciences Centre
Winnipeg

Corporate Office

Helga Bryant
Vice President &
Chief Nursing Officer
JBRC 709
Ph: (204) 787-3315
Fax: (204) 787-3912
hbryant@hsc.mb.ca

July 26, 2007

To Whom It May Concern:

I am pleased to write this letter in support of Asha Pereira for her proposed pilot project to study the Sleep/Wake Patterns of Critical Care Nurses. There has been much written in the literature about the effects of sleep deprivation and fatigue upon healthcare providers and their patients. However, there is little evidence about the actual sleep and wake patterns of critical care nurses who are for the most acute population of patients.

As this study will focus upon nurses who are informed and able to give consent, it is my feeling that this study will not distress or cause undue burden upon the nursing staff who agree to participate.

Developing an understanding of the sleep and wake patterns of critical care nurses will allow staff to learn strategies that will facilitate optimizing their sleep so that the potential effects of deprivation may be offset. It will also allow strategies to be developed at a systemic level to support nurses who are working within the critical care environment. This will translate to enhancement of patient and self care.

Therefore, I would like to offer my support for this study and wish Asha well on this endeavour.

Sincerely,

Helga A. Bryant
Vice President & Chief Nursing Officer

HB/jc

Appendix L

Health Sciences Centre
Winnipeg

Patient Services

Children's Hospital

Susan Fogg RN, MN
Program Director, Child Health, WRHA
Director of Patient Services, Children's Hospital, HSC

August 21, 2007

To Whom it May Concern:

Subject: Pilot Study; the Sleep/Wake patterns of Critical Care Nurses

I am pleased to write this letter in support of Asha Pereira for her proposed pilot project to study the Sleep/Wake Patterns of Critical Care Nurses. There has been much written in the literature about the effects of sleep deprivation and fatigue upon healthcare providers and their patients. However, there is little evidence about the actual sleep and wake patterns of critical care nurses who care for the most acute population of patients.

As this study will focus upon nurses who are informed and able to give consent, it is my feeling that this study will not cause distress or undue burden upon the nursing staff who agree to participate.

Developing an understanding of the sleep and wake patterns of critical care nurses will allow staff to learn strategies that will facilitate optimizing their sleep so that the potential effects of deprivation may be offset. It will also allow strategies to be developed at a systemic level to support nurses who are working within the critical care environment. This will translate to enhancement of patient and self care.

Therefore, I would like to offer my support for this study and wish Asha well in this endeavor.

Yours sincerely,

Susan Fogg, RN, MN
Program Director, Child Health, WRHA
Director of Patient Services, Children's Hospital, HSC

SF/sam

Appendix M

Winnipeg Regional Health Authority
Office régional de la santé de Winnipeg
Caring for Health
À l'écoute de notre santé

August 17, 2007

To: **Whom it May Concern**

From: **Betty Lou Rock, Program Director, WRHA Critical Care Program**

Subject: **Pilot Study; the Sleep/Wake Patterns of Critical Care Nurses**

I am pleased to write this letter in support of Asha Pereira for her proposed pilot project to study the Sleep/Wake Patterns of Critical Care Nurses. There has been much written in the literature about the effects of sleep deprivation and fatigue upon healthcare providers and their patients. However, there is little evidence about the actual sleep and wake patterns of critical care nurses who care for the most acute population of patients.

Developing an understanding of the sleep and wake patterns of critical care nurses will allow staff to learn strategies that will facilitate optimizing their sleep so that the potential effects of deprivation may be offset. It will also allow strategies to be developed at a systemic level to support nurses who are working within the critical care environment. This will translate to enhancement of patient and self care.

The study will not impose undue workload stress on the units and could be accommodated.

I would like to offer my support for this study and wish Asha well on this endeavor.

Appendix N

The sleep-wake patterns of critical care nurses: A pilot study

Researcher: **Asha Pereira, RN, BA, BN, CNCC(C)**

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The purpose of this study is to seek an understanding of the sleep and wake patterns of critical care nurses who practice within a shift work schedule. I am conducting this research as part of my Masters of Nursing degree at the University of Manitoba. It is hoped that what is learned from this study will help nurses and others who work within a shift work schedule understand the effect of shift work upon their sleep and wake patterns. The members of my thesis committee are Dr. Diana McMillan, Dr. Wendy Fallis and Dr. Eleni Giannouli. If you agree to participate, you will be asked to provide the researcher with a date and time you may be contacted by telephone. Once contacted by telephone, the researcher will arrange to meet you at a time convenient to you. At the first meeting, you will be asked to fill out a demographic questionnaire (e.g., gender, years of nursing experience, number of dependents), a 10-item sleep quality index, and a short sleep timing questionnaire, to assess your usual sleep habits. The estimated time of completion for these three items will be 15 – 30 minutes.

The second component of the study will involve the wearing of an actiwatch for 24 hours a day for 10 days, and the completion of a brief daily sleep log and short daily questionnaire to measure fatigue. Following the completion of the initial questionnaires, the researcher will review the Actiwatch® instructions with you and provide you with an Actiwatch® and an envelope containing: a) written instructions on the care of the Actiwatch® b) a sleep log, which you will be asked to complete for each of the 10 days of data collection; and c) the Epworth Sleepiness Scale (ESS), which you will complete on each of the 10 days after you have been awake for at least 4 hours. In addition, on the morning immediately following the last night shift, you will complete the ESS, as soon as you get home. You will only do this for the first set of night shifts you may be working during the duration of the study. Completion of the ESS is estimated to take less than 5 minutes. Completion of the sleep log is expected to take 10 minutes per day. On day 2 and day 9 the researcher will contact you at an agreed upon time, to answer any questions and to arrange a time to retrieve the Actiwatch® and envelope containing the sleep log and Epworth Sleepiness Scale. Ideally the items will be retrieved on day 10. You are welcome to call the researcher at any time if you have questions about any aspect of the study.

Actigraphs are small electronic devices that are placed on the wrist to record movement. It is an easy to use, lightweight, portable instrument that is the size of a small sports watch and is traditionally worn on the wrist. The Actigraph wrist activity technology is based on the fact that during sleep, there is little movement, whereas during wakefulness there is increased movement.

You will be asked to place the unit on your non-dominant wrist and to wear the device for ten days. While the device is water resistant, you should remove the Actiwatch® temporarily, if you will be participating in heavy contact sports or activities, or if it will be submerged in water (e.g., swimming, shower/bathing). If you remove the device, please record time of removal, the reason why the device was removed, and when the device is replaced.

Two copies of the consent will be signed and one signed copy will remain with the investigator and the second will be left for your records.

Please indicate if you would like a summary of your individual sleep/wake patterns, and or a summary of the study findings (see attached sheet). Upon completion of the study, you will be provided a gift certificate valued at $5.00 for a local coffee shop as a small token of appreciation.

All demographic forms will be numerically coded and locked in a secure cabinet in the investigator's home. The surveys will also be numerically coded and stored separately from the informed consent forms and the demographic information. Only the investigator will have access to the identifying information. Electronic computer data will be coded numerically and secured on a password protected USB memory stick that will kept in a locked cabinet in the investigator's home. The actigraph data will be stored in secure password protected computer files in the supervisor's locked office. The data will be kept for a maximum of seven years, upon which time it will be destroyed. The destruction of the data will be done by using the services of a confidential paper shredder. The electronic file will be crushed.

Individual responses and activity data will be kept confidential. You will not be identified personally at any time. All study findings will be summarized into aggregate form, and all identifying responses will be removed. The information collected will be disseminated through journal publications and presentations at local, national and international conferences.

There will be no deception or coercion associated with any of the procedures.

You will be offered a small $5.00 gift certificate for a local coffee shop for your participation. Time is the primary investment required by you. The first meeting and set of questionnaires will take up to 30 minutes to complete. After that, you will be required to wear the Actigraph for 10 days and will be asked to fill out the questionnaires, sleep logs and surveys, which are expected to take about 15 minutes per day to complete. There are no perceived risks or legal implications for you and no harmful effects are anticipated. The Actiwatch® collects data automatically and will not interfere with patient monitors or other hospital equipment. Every effort will be made to provide you with information and support as required. There is no direct benefit to you, but you will be contributing to an understanding of the sleep/wake patterns of critical care nurses and will help to further the research into the understanding of the effects of shift work upon critical care nurses.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researcher, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and/or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so that you should feel free to ask for clarification or new information throughout your participation. If you have any questions or concerns, please feel free to contact me or my thesis Supervisor at the number listed below.

Investigator:

Asha Pereira, RN, Master of Nursing Student
Tel. xxx-xxxx

Supervisor:

Dr. Diana McMillan, RN, PhD
Assistant Professor, Faculty of Nursing
Tel. xxx-xxxx

This research has been approved by the Education and Nursing Research Ethics Board at the University of Manitoba and has been supported by the Health Sciences Centre Nursing Administration and your unit managers. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Secretariat at 474-7122 or e-mail Margaret_Bowman@umanitoba.ca. A copy of this consent is form has been given to you to keep for your records and reference.

______________________________ ______________________
Participant's Signature Date

______________________________ ______________________
Researcher's Signature Date

I would like a summary of the study findings: __Yes __No

I would like a copy of my sleep/wake patterns __Yes __No

Please send the information to the following address:

____

____

____

____

Appendix O

Sleep/Wake Patterns of Critical Care Nurses Checklist

DOCUMENT		COMPLETED
Consent	Copy 1 Signed	
	Copy 2 Signed	
Demographic questionnaire		
Pittsburgh Sleep Quality Index		
Sleep Timing Questionnaire		
Actigraphy information sheet		
Sleep log and Epworth Sleepiness Scale	Day 1 __/__/07	
	Day 2 __/__/07	
(Complete 4 hours after awakening)	Day 3 __/__/07	
	Day 4 __/__/07	
	Day 5 __/__/07	
	Day 6 __/__/07	
	Day 7 __/__/07	
	Day 8 __/__/07	
	Day 9 __/__/07	
	Day 10 __/__/07	
Epworth Sleepiness Scale (immediately upon return home: post last-night shift)	__/__/07	
Actigraphy watch		

Please contact researcher if you have questions or concerns

Contact Information:

Asha Pereira
Home phone number: xxx-xxxx
Work phone number: xxx-xxxx
Cell phone number: xxx-xxxx

Date and location of pick-up of equipment and documents:

____