Olivet Nazarene University
Digital Commons @ Olivet

Ed.D. Dissertations
School of Graduate and Continuing Studies

5-2013

Waking Up To Safety: An Examination of Work Hour Guideline Implementation and Education for Registered Nurses

Bonnie J. Schleder
Olivet Nazarene University, bjschleder@olivet.edu

Follow this and additional works at: https://digitalcommons.olivet.edu/edd_diss

Part of the Health Policy Commons, Nursing Administration Commons, and the Other Nursing Commons

Recommended Citation

Schleder, Bonnie J., "Waking Up To Safety: An Examination of Work Hour Guideline Implementation and Education for Registered Nurses" (2013). *Ed.D. Dissertations*. 61.
https://digitalcommons.olivet.edu/edd_diss/61

This Dissertation is brought to you for free and open access by the School of Graduate and Continuing Studies at Digital Commons @ Olivet. It has been accepted for inclusion in Ed.D. Dissertations by an authorized administrator of Digital Commons @ Olivet. For more information, please contact digitalcommons@olivet.edu.

WAKING UP TO SAFETY: AN EXAMINATION OF WORK HOUR GUIDELINE IMPLEMENTATION AND EDUCATION FOR REGISTERED NURSES

by

Bonnie J. Schleder

Dissertation

Submitted to the Faculty of

Olivet Nazarene University

School of Graduate and Continuing Studies

in Partial Fulfillment of the Requirements for

the Degree of

Doctor of Education

in

Ethical Leadership

May 2013

WAKING UP TO SAFETY: AN EXAMINATION OF WORK HOUR GUIDELINE

IMPLEMENTATION AND EDUCATION FOR REGISTERED NURSES

by

Bonnie J. Schleder

Dissertation

Dissertation Adviser — Date 4/20/13

Dissertation Reader — Date 4/20/13

Dissertation Coordinator — Date 4/20/13

Program Director — Date 6-14-13

Vice-President for Graduate and Continuing Education — Date 6/14/13

© 2013

Bonnie J. Schleder

All Rights Reserved

ACKNOWLEDGEMENTS

I would like to acknowledge my professors, advisor, reader, and colleagues of Cohort IV for their encouragement and dedication. Special acknowledgement to Dr. Rosalie Tuttle and Dr. Christopher Baglio who spent a significant amount of time sharing their knowledge and expertise. Their direction was invaluable. A special thanks goes to Shirley and Judy for assisting me with the finer details of the dissertation.

I would also like to acknowledge my sisters for their patience and care they provided my mother during times I could not be there. To my sons, Brad and Jon, for their listening skills, as I shared with them my dissertation and doctoral process, I always felt their encouragement. Lastly, to my husband John, who spent much time without his wife and for his understanding of the need for dissertation vacations. Your love and encouragement to keep going helped me achieve this goal. I love you.

DEDICATION

This dissertation is dedicated to my loving father who had faith that I would be successful in obtaining a doctoral degree. I know he is proudly looking down from above. May God continue to hold him in his hands.

ABSTRACT

The link between health care worker fatigue and adverse events is inseparable. Errors made by registered nurses correlated with work duration, overtime and the number of adverse events (Page 2004). To promote patient safety, nurses must remain vigilant. This study determined if work hour guidelines and education regarding safety risks affected nurse work hours, the use of fatigue countermeasures, and patient outcomes. The researcher explored survey data (n=597), actual work hours, patient safety events, and quality outcomes. Data collected demonstrated nurses work hours exceeded recommendations for a safe environment. The introduction of voluntary work guidelines and education did not result in a statistically significant change in primary work hours, $F\ (2, 556) = 2.005$, $p > .05$, secondary work hours, $F\ (2, 119) = 0.372$, $p > .05$, typical work hours in a day, $\chi^2_{(4)} = 1.086$, or in payroll reports of greater than 100 hours worked in two weeks, $\chi^2_{(2)} = .295$, $p > .05$. There was statistical significance noted in the reduction of greater than three 12-hour shifts in a row, $\chi^2_{(3)} = 7.810$, $p < .05$. The survey also demonstrated that nurses did not routinely use countermeasures to combat fatigue; however, there was a statistical difference in total countermeasure use following work hour guidelines and fatigue education, $F\ (2, 592) = 7.758$, $p < .01$. No statistical difference occurred in adverse safety events or quality outcomes following the implementation of work hour guidelines and education; however, the numbers were small.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

CHAPTER I

INTRODUCTION

"To err is human" was the beginning of a proverb written by Alexander Pope in his poem "An Essay on Criticism" (as cited in Poetry Foundation, 2009, p. 8). When an error occurs that affects a human life, emotional devastation lasting days or years results in feelings of fear, guilt, anger, and anguish (Christiansen, 1992). The Institute of Medicine, a not-for-profit independent advisor to improve health in its consensus report by Kohn, Corrigan, and Donaldson (2000) estimated at least 44,000 and as many as 98,000 hospitalized Americans died each year because of medical errors.

> This alarming number, which reflects only deaths occurring in hospital settings, exceeds the numbers of fatalities due to motor vehicle accidents, breast cancer, or [autoimmune deficiency syndrome] AIDS. Moreover, this does not reflect the many patients who survive, but sustain serious injuries. (Page, 2004, p.1)

Even after this astonishing report, between the years of 2006 and 2008, there were 99,180 deaths potentially caused by safety events. Not considering emotional costs, actual dollar costs associated with these safety events equaled 8.9 billion (May & Fortner, 2010). Of these safety event related deaths, 97.2 %, or 96,402 were potentially avoidable.

Leape et al., (1995) in a six-month study of medication errors, determined that nurses were responsible for the interception of 85.7 %, or 78, out of 91 medication errors. Nurses must remain vigilant to promote safe patient care. Scott, Rogers, Hwang, and Zhang (2006) conducted research that determined how nurses' work hours affected

vigilance and patients' safety. The authors concluded, "longer work duration increased the risk of errors and near errors and decreased nurses' vigilance" (p. 30). The risk of error was three times higher when nurses worked 12.5 or more consecutive hours and nurses who worked more than 40 hours per week had increased errors and near errors (Rogers, Hwang, Scott, Aiken, & Dinges, 2004).

When nurses worked consecutive 12-hour shifts, they slept an average of 5.5 hours per day (Trinkoff, Le, Geiger-Brown, & Lipscomb, 2007). Reduced opportunity for sleep affected public safety since it correlated with performance failures (Mitler, Miller, Lipsitz, Walsh, & Wylie, 1997). Barger et al. (2006) in their study of medical residents stated, "the hours of reported sleep per month decreased as the number of extended-duration work shifts, the number of reported medical errors, and the number of reported attentional failures increased …" (p. 2444). Sleep deprived staff demonstrated decreased reaction times and difficulty staying awake (Balkin et al., 2004). In a study by Dawson and Reid (1997), the authors demonstrated that after 17 hours of sustained wakefulness, cognitive performance decreased to a level equivalent to the performance of a blood alcohol level of 0.05 %. After 24 hours of sustained wakefulness, observed performance was similar to a blood alcohol level of 0.10 %, which is above the legal limit and defined as intoxication.

The hours worked by registered nurses were of particular concern since they provided the bulk of patient care (Rogers, 2004). Page (2004) identified that approximately 5,100,000 nurses and nursing assistants provided patient care. These nurses and nursing assistants were 54 % of the country's health care workers (Page). Page recommended work guidelines to reduce error-producing fatigue. In a review of the

literature, it was found that state legislations for employer mandated overtime existed; however, voluntary overtime was not addressed (American Nurses Association, 2010).

"Fatigue caused by too many work hours and sleeping too few results in profound sleepiness that can deteriorate a nurse's alertness, productivity and safe patient care" (Hughes & Rogers, 2004, p. 36). A considerable disregard for fatigue related errors existed among nurses who voluntarily worked extended hours as exemplified in the case of Julie Thao. On the July 4th holiday in 2006, Ms. Thao volunteered to work an extra shift, a total of 16 hours. She slept at the hospital at the end of the two shifts. She began another shift at seven o'clock in the morning; however, about 20 hours into the 28-hour period she hung an anesthetic medication instead of the intravenous penicillin prescribed to treat an infection. A cardiac arrest occurred in this 16-year-old pregnant patient and she died. The infant delivered by cesarean section lived. The Wisconsin Board of Nursing suspended her license for nine months and she lost her job (Wisconsin Department of Regulations & Licensing, 2006). Ms. Thao initially charged with criminal neglect subsequently pled no contest, and later was found guilty on two misdemeanors (*State of Wisconsin v Thao*, 2006). In court, Ms. Thao talked about her emotional devastation that centered on anguish and remorse that became a life sentence. This situation exemplified the need for fatigue countermeasure education and work hour guidelines to minimize human errors.

Statement of the Problem

Hospital deaths attributed to medical errors continue at an alarming rate. May and Fortner (2010) reported there were 96,402 potentially avoidable hospital deaths over a two-year period. Seminal work by Adams (1879) in the railroad industry reported fatigue

from excessive work hours as a safety risk factor. Fatigue-related errors increased as the number of extended shifts increased (Barger et al., 2006). Work hour regulations and education to improve safety practices were in place for other safety-sensitive professions such as pilots and medical interns; however, restriction of nurses voluntary work hours in hospitals was not known to be studied (Rogers, 2004). In addition, limited research was present on the efficacy of nursing fatigue countermeasure educational programs (Rogers). No evidence existed on the effect of nurse work hour guidelines and education on excessive work hours, patient safety events, and nurse-sensitive patient outcomes. If there was truly a societal safety concern, this must be determined. The purpose of this study was to determine if work hour guidelines and education regarding safety risks had an impact on nurses excessive work hours, fatigue management practices, and patient outcomes**.**

Background

In 1907, the Federal Hours of Service Act limited those engaged in or connected to the movement of trains to consecutive work of 16 hours and required a 10-hour rest break between shifts. Employees whose jobs related to train dispatch and those who ordered trains were restricted to work no greater than 13 hours in a 24-hour period, except in the case of an emergency ("Public Laws," 1907). This act was executed because between the years of 1902 and 1907 over 19,000 employees and passengers were killed in railroad accidents (U.S. Congress Office of Technology Assessment, as cited in Rogers, 2004). Despite the unknown actual number of employee work hours during this time period, railroad employees identified fatigue as a safety risk factor from excessive work hours (Adams, 1879).

Disasters attributed to fatigue from excessive work hours included the spillage from the oil tanker Exxon Valdez off the coast of Alaska and the Colgan air crash in New York (Exxon Valdez Oil Spill Trustee Council, 1990; National Transportation Safety Board, 2009). United States regulations on limited flight time and mandated pilot rest had been in place since the 1940's; however, the Colgan air crash in 2009 led to proposed stricter guidelines (Arnoult, 2009). In response to adverse safety events, work regulations throughout the years had expanded to include military personnel, nuclear power plant workers, marine employees, truck drivers, aerospace industry employees, and medical residents (Rogers, 2004).

In response to the death of an 18 year old woman in a New York teaching hospital in 1984, regulations were enacted five years later that prohibited New York medical residents to work schedules greater than 80 hours per week and no more than 24 hours straight (Wallack & Chao, 2001). In a 2002 report by the Accreditation Council for Graduate Medical Education (ACGME), nationwide regulations restricted medical residents to an 80-hour workweek. Landrigan et al. (2004) conducted a study that compared the medical residents' traditional schedule to a new shorter interventional schedule over 2,203 patient-days that involved 634 admissions. The rate of all serious medical errors was 22% higher with the traditional schedule, 193.2 versus 158.4 errors per 1,000 patient days. The results were statistically significant, $p < .01$, and demonstrated that more errors occurred when interns worked frequent 24 hours shifts when compared to the shorter interventional schedule. In September of 2010, new approved revised standards by the ACGME were developed. These standards, adopted by July 2011, restricted duty to no longer than 24 hours while on site and no longer than 16

hours for first year residents. Strategic napping after 16 continuous work hours was strongly suggested (Accreditation Council for Graduate Medical Education, 2011).

Fatigue and sleepiness affected patient safety because health care workers must be able to provide attention, sound judgment, and quick reaction times especially in emergencies (Jha, Duncan, & Bates, 2001). Fatigue was more frequent among women in an intense work environment, in those who worked overtime, and in physically strenuous work (Akerstedt, Fredlund, Gillberg, & Jansson, 2002). The amount of required sleep differed in individuals; however, most people required eight hours of sleep per day (Rosekind et al., 1997). The American Academy of Sleep Medicine has acknowledged that 33% of individuals sleep less than six hours per night (Fuller & Bain, 2010). Impaired cognitive performance equivalent to two nights of total sleep deprivation was known to occur if sleep was six hours or less (Van Dongen, Maislin, Mullington, & Dinges, 2003). In a pioneer study by Friedman, Bigger, and Kornfield (1971), medical residents had twice as many errors in reading heart electrograph tests when sleep deprived as compared to when they had a good night sleep.

Fatigue-related errors also increased as the number of extended shifts increased (Barger et al., 2006). Barger, et al. stated:

> During the months of frequent extended-duration, work shifts (i.e. five or more extended duration shifts in the month), interns were significantly more likely to fall asleep during surgery, while talking to or examining patients, during rounds, and during lectures or seminars, potentially affecting their ability to deliver patient care or to learn. (p. 2444)

In 2004, the Committee on Work Environment for Nurses and Patient Safety stated, “work hours of a minority of nurses, in particular, are identified as a serious threat to the safety of patients” (as cited in Page, 2004, p. 12). Recommendations included prohibiting nursing staff from working overtime, mandatory or voluntary hours in excess of 12 hours in any 24-hour period and in excess of 60 hours per seven-day period (Page). In an effort to implement similar work hours, the state of Texas proposed legislation; however, severe opposition by nurses resulted in legislation dismissal (Texas Board of Nursing, 2007a). Therefore, the effects of nurse fatigue continued as a serious threat to patient safety.

The total number of work shifts that nurses were allowed to work was only minimally restricted. According to the Department of Labor, State of Illinois (2003), the only work hour restriction was a minimum of 24 hours of rest every calendar week. No state or federal regulations limited the number of hours a nurse may voluntarily work in 24 hours (Page, 2004). Louwe and Kramer (2001) noted the use of overtime to cope with the shortage of nurses in their study of nursing staff in hospitals and nursing homes. Interviews with registered nurses, licensed practical nurses, and nursing assistants revealed in 13 of the 17 facilities at least one nursing staff member had worked between one and three 16-hour shifts during the previous seven days. At one study facility, more than one-third of the nursing staff had worked between eight and 11 shifts of 16 hours per day in the past 14 days. This study by Louwe and Kramer did not include hours worked at additional jobs.

Trinkoff, Geiger-Brown, Brady, Lipscomb, and Muntaner (2006) determined that 19.4% or 440 nurses out of 2,273 worked more than one job. Nurses with more than one

job were more likely to work 50 hours or more per week. They also worked more consecutive days without breaks and more days in a row. Extensive overtime also contributed to adverse patient outcomes. Stone, et al. (2007) in a study of work conditions and patient outcomes of care, identified that increased overtime was associated with higher rates of patient urinary tract infections and skin ulcerations.

Recognizing the associated quality and safety risks, The American Nurses Association (2006a) in its policy statement regarding work hours identified that employers must provide "a work schedule that provides adequate rest and recuperation between scheduled work with sufficient compensation and appropriate staffing systems to foster a safe and healthful environment…" (para. 5). The American Organization of Nurse Executives (2003) in its policy on overtime stated:

> Ultimately, it is the individual nurse who must be accountable to assess his or her ability, within the parameters of one's physical, mental and emotional state, to either accept or decline extra hours as a competent and safe care provider at the patient side. (para. 7)

According to Scalense (2006), The Joint Commission in their proposed safety goals for 2008 encouraged hospitals to identify and educate on worker fatigue; however, the 2011 Joint Commission national patient safety goals had not required employee fatigue education (The Joint Commission, 2010). In December of 2011, The Joint Commission issued a Sentinel Event Alert that suggested educating staff about sleep hygiene and the effects of fatigue on patient safety; however, this also was not mandated. According to the Federal Aviation Administration (2010a, 2010b, 2010c), fatigue mitigation in the

airline industry was the responsibility of both the employer and employee and educational programs for pilots became mandatory.

Rogers (2004) described the needed fatigue mitigation content for nurse educational programs. Fatigue educational programs traditionally included information about circadian rhythms, sleep hygiene measures, the adverse affects of shift work, and countermeasures for fatigue prevention. Some educational programs have also included information on sleep disorders. The goal of fatigue education programs was to encourage employees to take responsibility for sufficient sleep to remain alert. "Although over 170,000 employees have been exposed to fatigue countermeasures programs, there is very limited information about their efficacy" (p.416). In 1927, Charles Lindbergh described fatigue best during his 33.5-hour flight across the Atlantic:

> My mind clicks on and off. I try letting one eyelid close at a time when I prop the other open with my will. But the effort's too much. Sleep is winning. My mind is losing resolution and control. (Printup, 2000)

Research Questions

The interest promoting patient safety through the development of work hour guidelines and education has led to the following research questions:

1. What impact did work hour guidelines and fatigue education have on the implementation of fatigue management countermeasures?
2. What impact did work hour guidelines and education have on hours worked?
3. What impact did the implementation of work hour guidelines and education have on adverse safety events?

4. What effect did the implementation of work hour guidelines and education have on nurse-sensitive patient outcomes?

Description of Terms

Skin ulcerations. Impairment of skin caused by pressure as defined by the Nosocomial Infections Surveillance system (Stone et al., 2007).

Excessive work hours. Hours worked above a predetermined, regularly scheduled full-time or part-time work schedule, as determine by established work scheduling practices (American Nurses Association, 2010).

Fatigue. Diminished capacity to do work accompanied by a subjective feeling of tiredness (Rogers, 2004).

Fatigue countermeasures. Methods, practices, materials, substances, or other elements that can counteract the effects of fatigue (Federal Aviation Administration, 2008).

Medical errors/adverse safety events. Unintentional injuries or complications caused by health-care management rather than by the patients' underlying condition (Balas, Scott, & Rogers, 2004).

Nurse-sensitive patient outcomes. Results which focus on how patients and their healthcare problems are affected by nursing interventions (Oncology Nurses Association, 2004).

Significance of the Study

As many as 98,000 hospitalized Americans died each year because of medical errors (Kohn, et al., 2000). A contributing cause was fatigue from excessive work hours (Barger et al, 2006). Nurses' direct interaction with patients provides a unique position as

the gatekeeper for safe patient care (Leape et al., 1995). Nurses must remain vigilant for patient safety (Scott, et al., 2006). Work-hour guidelines and education on fatigue countermeasures had been required in several safety-sensitive jobs; however, minimal requirements existed for nurses that volunteered to work overtime (Rogers, 2004).

This study implemented work-hour guidelines and fatigue countermeasure education. Data examined in the study included fatigue countermeasures, work hours, adverse safety events, and quality patient outcomes. Measured work hour data included the total number of hours worked at all jobs. The ultimate goals included the prevention of safety events and improved quality patient outcomes. The potential improvement in patient outcomes, may result in decreased mortality, decreased infections, and improved patient care attentiveness. Fewer errors will decrease the frequency of emotional devastation that occurs with errors. This study could also encourage other clinical professions to conduct research on fatigue as well as encourage other hospitals or governmental agencies to mandate work hour guidelines for all individuals in clinical positions. Additional fatigue management programs that target specific needs of the professional nurse or other clinical positions may also develop.

Process to Accomplish

The methodology for this study was quantitative. The research study utilized a purposive sample of clinical nurses who worked at one of the two designated hospitals located in the Midwest. The nurses worked in departments that had 24-hour patient care responsibilities. The inclusion criteria required participating registered nurses be employed at their designated hospital during the research study. Excluded from the sample were non-clinical nurses. Non-clinical nurses included administrators, educators,

managers, quality, and risk management nurses. The study excluded clinical nurses who were required to report to work for emergencies, such as on call nurses. Nurses employed by the research hospital and included in the study completed a computer-based educational safety program on fatigue countermeasures. Work hour guideline implementation and the computer-based education program had already taken place at the study hospital; therefore, this research study utilized an ex post facto design. In ex post facto designs, identified events had already occurred and subsequent data collected determined current behaviors (Leedy & Ormrod, 2010). The study used a quasi-experimental design, specifically a comparison of the research and control groups, as well as a pre-posttest design within the research hospital (Salkind, 2009).

The principle investigator developed the computer-based safety education program with input from clinical nursing staff. Prior to program finalization content experts and nurse educators reviewed the program. The computer-based safety program provided education on the risk of medical errors associated with excessive work hours and included fatigue countermeasures.

A comparative hospital within the same hospital system established a control group that used the inclusion and exclusion criteria; however, the control group did not implement the work hour guidelines or complete the computer-based safety education program during the study. Both the control group and research group voluntarily completed the fatigue countermeasure survey developed by the primary researcher. Randomization of groups did not occur. Data from the survey included questions that determined the participants' demographics, self-reported work hours, and information regarding the use of fatigue countermeasures. Data collection resulted in three distinct

groups, pre-intervention, post-intervention, and no intervention. Statistical analysis of the survey results utilized ANOVA and chi-square. Group IV, developed from Group I and Group II, though the identification of matched-pairs was analyzed using dependent *t*-test.

Additional data obtained included actual nurse work hours using schedules and Human Resource Department payroll reports. Actual work hours were analyzed using crosstabs/chi-square. Adverse safety events also collected, included the type of event, and noted harm. Chi-square and *z*-tests were utilized to analyze these results. Patient volumes were obtained to determine the proportions necessary to calculate the *z*-score. Reported nurse-sensitive indicators that included patient falls and hospital acquired pressure ulcers were analyzed using chi-square.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Kohn, et al. (2000) initially estimated that as many as 98,000 hospital Americans died each year because of medical errors. Between the years 2006 and 2008, medical errors resulted in a cost of 8.9 billion dollars (May & Fortner, 2010). From 2007 through 2009, mortality due to medical errors decreased to 79,670 (Reed & May, 2011). Despite this 18.7% noted improvement, medical harm continued to represent a significant amount of preventable deaths. In fact, Reed and May concluded that one in 10 surgical patients died following the development of a serious but preventable complication. Additionally, the numbers above did not reflect the many survivors who sustained serious injuries due to errors. One example of a healthcare preventable injury was wrong site surgery for which the national occurrence was as high as 40 per week (Page, 2004; Center for Transforming Healthcare Aims to Reduce Wrong Site Surgery, 2011).

Between the years 2007 and 2009, the significance of medical errors affected 708,642 hospital patients. These patients were subjected to one or more preventable patient safety events (Reed & May, 2011). At this time a major thrust to decrease medical errors and improve patient safety occurred. HealthGrades publicly awarded a Patient Safety Excellence Award to hospitals demonstrating excellent patient safety. Reed and May projected that 20,688 Medicare deaths and 174,358 patient safety events could have been avoided if all hospitals performed at the level of these excellent hospitals. This

would have resulted in a Medicare savings of 1.8 billion dollars from 2007 through 2009 (Reed & May). These statistics demonstrated the potential benefits of decreased medical errors.

The national challenge to make health care safer continued. Hospital associations, professional societies, and accrediting bodies developed an interest in transforming the healthcare environment. The emphasis was on system design and communication regarding the need for a culture of safety (Leape & Berwick, 2005). However, regardless of how well systems were designed, individuals remained fallible, and the best-designed systems were designed by fallible individuals (Page, 2004). Personal commitment by those that participated in this culture remained a challenge. Creating a culture of safety required behavior changes that professionals felt were a threat to their individual autonomy, regardless of the effect on patient safety (Leap & Berwick). Loss of autonomy with work hours became one of those threats.

To examine the current culture of safety, Scott, et al. (2006) determined how nurses' work hours affected patient safety. A random sample of critical care nurses agreed to complete two 14-day logs books. Information collected included hours worked, time of day worked, overtime, days off, and sleep-wake patterns. The participants recorded difficulty staying awake while on duty and described errors or near errors that occurred. Five-hundred and two nurses participated in the study. An examination of 6,017 work shifts revealed that nurses worked longer than the scheduled shift 86% of the time that equated to 5,175 shifts (Scott, et al.). Scheduled twelve-hour shifts occurred in 2,648, or 44%, of the examined work shifts. Additionally, 54 nurses, or 11%, worked more than 16 hours at least once (Scott, et al.). During the study period, almost two

thirds, or 331, of the participants stated they struggled to stay awake, and 20%, or 100, critical care nurses fell asleep at least once while on duty. Twenty-seven percent, or 136, nurses reported making at least one error and 38%, or 191, nurses reported making at least one near error (Scott, et al.). The authors concluded that longer work duration increased the risk of errors and decreased nurses' vigilance.

Nurses are expected to provide safe patient care, and safety depended on the vigilance of the bedside nurse (Dean, Scott, & Rogers 2006). In a two month analysis of critical incidents in a neonatal-pediatric intensive care unit, there were 211 potential or actual adverse events. Twenty out of 62 identified drug adverse events, or 32%, were potentially life-threatening. Doctors had the greatest portion of major adverse events. (Frey, et al., 2000). The most important method of prevention was routine checks. Leape et al. (1995), in a system analysis of adverse drug events, noted that of the 63 intercepted physician errors, 86%, or 55, potential medication errors were averted by registered nurses while the pharmacist intercepted 12%, or 8, adverse drug events. Nurses must remain vigilant to protect the patient.

Historical Perspective of Safety

Long work hours and resultant fatigue potentially contributed to errors that made rail travel dangerous (Adams, 1879). The execution of the United States 1907 Hours of Service Act followed the deaths of over 19,000 employees and passengers in railroad accidents between the years of 1902 and 1907 (U.S. Congress Office of Technology Assessment, as cited in Rogers, 2004). Even though death totals raised until the addition of signal inspections in the early 1920's, a 10-hour rest between workdays was required of employees engaged in or connected to the movement of trains. Those who performed

train dispatch or train orders were restricted to work no more than nine to 13 hours in a 24-hour period. Employees were not able to volunteer or mandatorily work beyond these hours (Public Laws, 1907). At this time, there were no studies to substantiate the interconnection between fatigue and work hours, but authors connected long working hours with a public safety risk (Rogers).

Between the years of 1990 and 1999 fatigue and safety concerns continued despite the presence of only 18 cases where train accidents became coded as operator error from falling asleep. Although some modifications to the Hours of Service Act occurred, work hour regulations remained approximately the same. One regulation required 10 consecutive hours off duty when 12 hours were worked (Public Laws, 2008). A greater understanding of fatigue and specific work-related factors and the implementation of fatigue countermeasures improved operational performance. Fatigue countermeasures included operator and manager education, alertness strategies, behavior-based safety methods, employee-scheduling practices, and the evaluation of policies and procedures (Sussman & Coplen, 2000; Coplen & Sussman, 2000).

The Motor Carrier Act of 1935 regulated the work hours of long-haul truck drivers (Edles, 2004). The Interstate Commerce Commission, a federal government agency established maximum hours for drivers for both economic and safety considerations. Enacted in 1937, the final version of The Motor Carrier Act for truck drivers required work hours to be restricted to 10 consecutive hours out of 24, with a minimum of eight off duty hours (Yager, 2009). Over the years several revisions took place which increased the driving hours up to 11 and the off duty hours to 10 (Yager). Current regulations for passenger-carrying vehicles included 10 maximum hours of

driving time, with a minimum of eight consecutive hours of rest time (GPO Access, 2011). Violators of regulations had higher crash rates (Braver, et al., 1992). Interestingly, over time the maximum hours of driving had returned to the original more restricted regulation.

In a study by Mitler, et al. (1997), 80 male truck drivers who drove 10 to 13 hours per day for five days had slept in bed an average of 5.18 hours per day. Sleep was also measured electrophysiologically and averaged 4.78 hours per day. Forty-five drivers, or 56%, had at least a six minute interval of drowsiness while driving. Although no motor vehicle crashes occurred, drivers in this study did not obtain enough sleep to remain alert.

Fatigue was also identified as an underlying cause of major disasters. Following the Exxon Valdez oil spill, the final investigative report identified one of the officers involved in the disaster that day had worked 18 hours (Exxon Valdez Oil Spill Trustee Council, 1990). The report later explained that excessive work hours and fatigue contributed to the Exxon disaster. This document also stated that at least 80% of marine accidents are attributable to human error (Exxon Valdez Oil Spill Trustee Council). Following this incident, specific hours of service for seamen and deck officers were developed. This included a minimum 10-hour rest period during a 24-hour period prior to port departures. Work hours while in port were limited to working no more than nine out of 24 hours. While at sea, work hours were limited to 12 hours per day; however, exceptions were allowed (GPO Access, 2010).

Extended work shifts were evaluated in a National Institute for Occupational Safety and Health research study (Rosa, 1991). The participants were natural gas workers doing sedentary mentally-demanding tasks and field workers performing physically-

demanding tasks. Specific assigned shift rotations included eight and 12-hour shifts. During this three and one-half year study, reasoning, reaction time, hand steadiness, and sleepiness were evaluated. The results suggested that test performance alertness was lower after 12-hours than with eight-hour shifts. The lowest scores were at the end of the 12-hour night shift. Of concern was the total sleep time after night shifts on the 12-hour shifts schedule. Sleep loss was associated with increased sleepiness and decrements in performance. "The reduced sleep time indicates a need for workers to make an effort to obtain more sleep during the workweek, even at the expense of other activities" (p. 115).

The Federal Aviation Administration had discussed the importance of work hour regulations for pilots since the 1940's. In 1972, the first safety recommendations were issued, but the aviation industry continued to identify serious fatigue concerns. Issues included sleep and circadian rhythm disruption (Department of Transportation, Federal Aviation Administration, 2010). Despite continued discussion for years, it took the crash of two airplanes, the Kirksville accident that killed 13 people in 2004, and the Colgan flight in Buffalo, New York that killed 50 people in 2009, to propose stricter recommendations for on duty time and rest hours (National Transportation Safety Board, 2009). In the final National Transportation Safety Board report of the Kirksville accident, pilot fatigue was identified as a likely contribution to the pilots' performance and decision capacity. The investigation into the Colgan disaster determined the pilots long commute time, inadequate sleeping arrangements, and a combination of other factors contributed to the demise. Investigators did not find fatigue was the only cause (National Transportation Safety Board).

In September of 2010, the Federal Aviation Administrator proposed new duty and rest regulations (Department of Transportation, Federal Aviation Administration, 2010). The language in the proposed rule was clear. The document read, “Fatigue threatens aviation safety because it increases the risk of pilot error that could lead to an accident” (p. 1). The document described fatigue types as transient, cumulative, and circadian. It explained that a variety of factors contributed to fatigue and included time of day, amount of recent sleep, time awake, cumulative sleep dept, individual variation, and time on task. In consideration of all these factors, fatigue management was identified as the responsibility of both the air carrier and pilot (Arnoult, 2009). Responsibilities included being fit for duty as well as being physiologically and mentally prepared to the highest degree possible. The new rule approved in 2011 set a 10-hour minimum rest period prior to duty and placed 28-day and annual limits on actual flight time. It also required that pilots had at least 30 consecutive hours free from duty on a weekly basis (Federal Aviation Administration, 2010a). Similar to the transportation industry, fatigue nurses threaten safety. Nurses must be physiologically and mentally prepared for duty to provide sound judgment and quick reactions, especially in emergencies (Jha, et al., 2001).

Work Hours in the Medical Profession

To foster a safe patient environment related to work hours, the American Nurses Association’s (2006a) position statement recognized the employers’ role was to provide scheduled work hours that promoted adequate rest and recuperation. The American Nurses Association (2006b) also presented the position that each nurse must carefully consider their fatigue level upon acceptance of a mandatory or voluntary assignment. The American Organization of Nurse Executives (2003) stated the nurse manager must

consider the total numbers of hours worked and the effects of fatigue on human performance when making assignments; however, ultimately it is the responsibility of the individual nurse to assess whether it is safe to accept additional work hours. In response to the case of The State of Wisconsin vs. Thao, the Wisconsin Organization of Nurse Executives (2008) proposed education and work hour recommendations as a critical step to address the issue.

Despite the development of work hour recommendations in other professions, no federal regulations existed for nurses (Rogers, 2004). Some state nursing regulations addressed mandatory overtime; however, voluntary overtime was not addressed, except for the “One Day Rest in Seven” law (American Nurses Association, 2010; Rogers). The “One Day Rest in Seven” law required employees be given 24 consecutive hours of rest in each calendar week (Department of Labor, State of Illinois, 2003). This did not result in rest every seven days since an employer may legally schedule 12 consecutive days within a two-week period if the days of rest fall on the first and last days of the two-week period. Another regulation enacted in the state of Maine required a minimum of 10 hours off if the nurse worked greater than 12 hours. Additionally, Oregon did not allow nurses to work greater than 16 hour in a 24-hour period of time (Rogers). Despite stricter regulations in many other safety sensitive industries, nurses work hours are only minimally restricted.

The Committee on Work Environment for Nurses and Patient Safety (Page, 2004), a subset of the Institute of Medicine (IOM), recommended regulatory bodies prohibit nursing staff from work, mandatory or volunteer, in excess of 12 hours in a 24-hour period (Page, 2004). The committee also recommended that nurses be restricted

from work greater than 60 hours in a 7 day period. To date, restrictions remain limited. In fact, when the Texas Board of Nursing (2007a) proposed similar work hour legislation, 11,785 nurses responded. This online survey represented 10,607, or 90%, of nurses that did not believe their work hours should be limited. Reasons cited for the opposition included staffing issues, right to work, family obligations, physical requirements, and financial hardship. Interestingly, 5,539, or 47%, of the respondents sometimes or frequently worked more than 60 hours per week and 7,660, or 65%, sometimes or frequently worked greater than 12.5 consecutive hours. A total of 6,205, or 81%, of the respondents voluntarily worked these hours. This opposition resulted in a mere statement that held each nurse accountable to accept assignments that are within the nurses' ability. It also identified the supervisor as responsible for overseeing the nursing care provided. Overall, work hours became the responsibility of the nurse accepting the assignment (Texas Board of Nursing, 2007b).

Rogers, et al., (2004) confirmed the presence of nurses extended shifts when they collected data on 5,317 work shifts. Hours worked beyond scheduled work hours were reported as overtime. Hospital staff nurses reported leaving work at the end of their scheduled shift less than 1,063 shifts, or 20%, of the time. Nurses worked an average of 55 minutes longer than scheduled each day and all participants worked beyond their scheduled shift at least once in the 28 days the data was being collected (Rogers, et al). Fourteen percent of respondents, or 55 nurses, reported working 16 hours or more at least once. The longest shift worked was 23 hours, 40 minutes. The proportion of nurses working overtime was significantly higher in eight-hour shifts compared to 12-hour shifts (Rogers, et al.).

Trinkoff, et al. (2006) conducted a randomly selected quantitative survey of 2,273 nurses in two states. Hospital staff nurses were 45%, or 1,020, of the respondents. Nurses reported the number of hours and minutes they actually worked per shift. Participants wrote in the number of shifts they typically worked in a row and the most days they worked in a row without a day off. Respondents also indicated if they worked more than one job and reported the number of extended workdays of 13 hours or more, with less than 10 hours off per day. Among all nurses including full time and part time workers, 33%, or 750, nurses worked greater than 40 hours per week (Trinkoff, et al.). Of the 2,273 nurses, 5.9%, or 134, nurses worked more than 60 hours per week. Greater work hours occurred since 19%, or 440, nurses worked more than one job (Trinkoff, et al.). Eight percent, or 182, nurses worked with less than 10 hours off between shifts at least once per week. Nurses with more than one job were more likely to work 12-hour shifts (Trinkoff, et al.). In addition, 29%, or 660, nurses worked six or more days in a row within the last six months. Eleven percent, or 250, nurses reported they usually did not take breaks during their work shift (Trinkoff, et al.). Single parents were more likely to work more than one job, greater days in a row, more hours per day, greater than 50 hours per week, and less likely to have 10 hours off between shifts (Trinkoff, et al.). Several of these findings violated the IOM's recommended work hours to achieve patient safety.

To reduce error-producing fatigue, the recommendation in the executive summary of the IOM included prohibiting nurses from providing patient care in excess of 12 hours. The IOMs acceptance of a 12-hour shift raised controversy (Page, 2004). Fields and Loveridge (1988) conducted a quasi-experimental research study of 102 critical care nurses to determine the effects of shift length on nurses' level of fatigue and critical

thinking performance. The two groups included nurses that worked eight or 12-hour shifts. The nurses were tested with the Three Minute Reason Test and the Subjective Symptoms of Fatigue Test during the first and last hours of their shifts. The symptoms listed on the fatigue test were valid to determine degree of drowsiness, difficulty of concentration, and projection of physical impairment (Fields & Loveridge). Total fatigue scores were significantly higher at the end of the shift when compared to the beginning of the shift; however, there was no difference between subjective fatigue scores of nurses who worked eight versus 12-hour shifts. Specifically, drowsiness and projection of physical impairment increased significantly during the work day; however, there was no significant increase in difficulty in concentration (Fields & Loveridge). Twelve-hour night shift nurses were drowsier, but there were no other noted differences between nurses that worked eight and 12-hours. Critical thinking demonstrated by the Three Minute Reason Test showed there was no difference in nurses who worked eight versus 12 hours. (Fields & Loveridge). "These study results would imply that the 12-hour shift is no more fatiguing than the 8-hour shift" (p. 190).

In a study of 99 nursing units, Stone, et al. (2007) identified no difference in patient quality outcomes from nurses that worked eight hours versus 12 hours. In a meta-analysis by Smith, Folkard, Tucker, and Macdonald (1998) "the bulk of the evidence suggested few differences between eight and 12-hour shifts in the way they effect people" (p. 217). Twelve-hour shifts showed benefits in, travel time, time off duty, staff morale, and reduced absences (Knauth, 2007; Smith, et al.) Major arguments against 12-hour shifts included a concern for compromised alertness and performance that resulted

in impaired safety. Research findings had not convincingly confirmed this fear (Knauth; Smith, et al.).

Successful 12-hour shifts depended upon schedule management because 12-hour shifts increased time awake and decreased sleep. As a 12-hour day workweek progressed, errors were more frequent on the fourth and fifth work day (Rosa, 1988). Fatigue-related errors increased as the number of extended shifts increased (Barger et al., 2006). Workers tolerated extra fatigue in exchange for other benefits the 12-hour schedule provided. Despite recommended work hours and the noted adverse effects of excessive work hours, nurse work schedules remained minimally regulated and became the responsibility of the individual nurse who often worked extended shifts, overtime, and successive days.

Even within the profession of medicine, the only work hour regulations were those set forth for medical residents and emergency department physicians. Regulations for emergency department physicians were found in New York and only applied to those departments with greater than 15,000 unscheduled visits. This regulation restricted the maximum work hour limit of physicians to12 to 15 hours per day (New York Codes, Rules & Regulations, 1998). Medical resident rules were established in New York in 1984 after the tragic death of an 18-year-old patient (Wallack & Chao, 2001). In this case, the grand jury found fault in the resident training system and staffing pattern. The medical resident involved had been awake for more than 18 hours straight (Wallack & Chao). The resultant Bell Regulations were enacted five years after the incident. Medical residents in New York were subsequently dictated a work hour maximum of 80 hours per week, 24 hours per day, and eight hours off duty between shifts. Surgical residents could work more than 24 hours if provided rest at the hospital. Hospitals were fined when they

had not abided by the work rules (New York State Department of Health, 1998). Physicians in opposition to this bill claimed that the grand jury confused professional incompetence with long working hours (Asch, & Parker, 1988).

The Graduate Medical Education Accreditation Council (2002) developed work hour standards that extended beyond the state of New York; however in a study by Landrigan, Barger, Cade, Ayas, and Czeisler (2006), the medical residents that completed the survey worked beyond their allowable hours. In 2011, stricter work hours were approved. The medical resident and subspecialty fellow standards implemented in July of 2011 included a maximum 80-hour workweek averaged over four weeks, including moonlighting. First year resident physicians had a 16-hour maximum work hour regulation, then after their first year, they were able to work 24 hours with one day off every week. Ten hours, but minimally eight hours off was required between duty periods. Strategic napping especially after 16 hours and between the hours of 10:00 pm and 8:00 am was strongly suggested. The standard also required the sponsoring institution provide adequate sleep facilities and safe transportation options for fatigued residents (Accreditation Council for Graduate Medical Education). These stricter regulations developed following the 2008 IOM's recommendation for work hours and a detailed review of scientific literature on sleep and patient safety.

Errors and Work Hours

A study by Lockley, et al. (2004), compared the traditional resident work hours with the regulated medical resident schedule. Twenty interns in the study completed daily sleep and work logs. Interns in the interventional schedule worked 19.5 hours per week less, increased their sleep by 5.6 hour per week, and slept more hours prior to work. The

interns underwent continuous polysomnographic monitoring which confirmed the hours scored in the sleep log. Attentional failures by the interns were identified by continuous electroculography. Interns on the interventional night schedule had less than half the rate of attentional failures compared with interns working the traditional night schedule (Lockley et al.).

Another study by Landrigan, et al. (2004) identified the medical error rate of interns in intensive care units during a traditional schedule and compared it to the interventional schedule. This study was a part of the Harvard Work Hours, Health and Safety Study from July 2002 to June 2003. The study included 2,203 patient days and involved 634 admissions. The interns' workweeks averaged 77 to 81 hours with up to 34 continuous hours of scheduled work time while on the traditional schedule. Interns on the intervention schedule worked 60 to 63 hours per week with consecutive hours of work limited to 16 hours. Interns made 35.9% more serious medical errors or 136 errors per 1,000 patient days during the traditional schedule than during the interventional schedule. This included 20.8%, or 99.7, medication errors per 1,000 patient days more with the traditional work schedule than with the interventional schedule.

Barger et al. (2006) assessed whether extended-duration shifts worked by interns were associated with significant medical errors, adverse events, and attentional failures. Medical residents participated in a survey on a monthly basis from July 2002 to May 2003. Residents were questioned about the amount of work hours, sleep, activities, days off, and extended-duration work shifts. Extended-duration work shifts included time at work for at least 24 continuous hours. Seven percent, or 155, of the participants also completed daily diaries to validate their time worked. The monthly survey identified that

81%, or 15,989, of the intern months abided by the Accreditation Council for Graduate Medical Education (2011) resident work hour guidelines. “The reported rates of fatigue-related significant medical errors were increased substantially as the number of extended-duration work shifts increased” (Barger, et al., p. 2442). Attention failures were also strongly associated with extended-duration work shifts. Attention failures included such items as falling asleep during surgery and nodding off during lectures or seminars. The authors concluded that extended-duration work shifts resulted in attentional failures and had adverse effects on patient safety. This confirmed the results of a previous study by Friedman, et al. (1971) that investigated the effects of sleep deprivation on the medical interns. The interns’ performance in reading cardiac rhythms was tested while rested and was compared with performance when fatigued. The interns were less able to recognize the rhythms when fatigued and admitted to difficulty in cognitive, perceptual, and physiologic function.

Rogers, et al. (2004), conducted a study of 393 hospital registered nurses who worked full time. The nurses were asked to complete a log book on work days and days off. Twenty-five percent of the nurses or 98 nurses worked greater than 50 hours per week. Nurses also worked 40% of the 5,317 shifts, or 2,127 shifts in excess of 12 hours. Within the four week period of time being recorded, there were 199 errors and 213 near errors reported by the nurses. The errors were associated with work duration, overtime, and the number of hours worked per week. Errors increased with longer work hours and were three times higher when nurses worked shifts of 12.5 hours or more. Overtime work increased the odds of making at least one error. The authors concluded that “hospital staff nurses’ long hours may have adverse effects on patient care” (p. 210).

In another study by Balas, et al. (2004), 502 critical care nurses were asked to record in logbooks for a period of 28 days. Over one-quarter of the participants reported making an error and more than one-third reported near errors during the study period. There were 127 medication administration errors that accounted for 56.7% of all errors. Watkins (2010) studied the impact of fatigue on medication errors by 30 medical/surgical nurses in a community hospital and determined there was a correlation between medication errors and nurses that worked more than 40 hours per week.

In a case study approach by Dean, et al. (2006), errors made by neonatal intensive care nurses were examined. Errors performed related to scheduling patterns, sleep deprivation, and the aging nursing population. The authors expressed their concern about 12-hour shifts because one of the nurses who performed a medication error had slept only 4.2 hours in the prior 24 hours and had worked three 12-hour night shifts in a row. In the second case study the nurse drew up twice the amount of Morphine, however she intercepted the error prior to administering the drug to the neonate. In contrast, this nurse had been off for several days, but reported sleeping a total of 4.6 hours in the previous 24 hours and struggled to stay awake during the shift. Circadian dysynchrony and sleep deprivation possibly contributed to this near error since this was her first night worked (Dean, et al.). These two case studies highlighted the importance of an individual's commitment to sleep to promote safety regardless of their work schedule.

Error rates also increased with the number of hours worked. Errors increased after 8.5 of hours worked and tripled after 12.5 consecutive hours (Hänecke, Tiedemann, Nachreiner, & Grzech-Sukalo, 1998; Rogers, et al., 2004). Due to the shortage of nurses, overtime hours, mandatory or voluntary were frequently worked in hospitals and nursing

homes (Louwe & Kramer, 2001). In a four week study by Rogers, et al., almost two-thirds of nurses worked overtime ten or more times. One-quarter of the nurses worked more than 50 hours per week for two or more weeks. Regardless of the length of the shift, working overtime increased the odds of making at least one error. Mandatory overtime only occurred in 6.8%, or 360 shifts, the remainder of overtime hours was voluntary (Rogers, et al.). Although not threatened by disciplinary action, approximately 60% or 2,554, of nurses that participated in an American Nurses Association Staffing Survey reported feeling as if they were forced to work voluntary overtime (Rogers, 2004).

Patient Outcomes and Work Hours

The extensive use of overtime had been identified as a contributor to infection outbreaks. In a review of 16 infected surgical patients at low risk for infection, there was an increase in both hours of operation and hours of overtime employment of operating room personnel (Russell, Ehrenkranz, Hyams, & Gribble, 1983). Monthly overtime during the outbreak increased to 11.9%, with a mean for all nurses and technicians of 189 ± 78 total overtime hours. Unexpected patient census and understaffing identified fatigued nurses who compromised the usual standards of care and rushed through aseptic procedures.

Stone, et al. (2007) also correlated increased overtime with higher rates of catheter-associated urinary tract infections and decubiti also known as skin ulcerations. In contrast, overtime was associated with a lower risk of central line catheter infections. The sample was comprised of 15,846 patients in 51 adult intensive care units in 31 hospitals where 1,095 nurses were surveyed. Objective data collected included staffing, overtime hours, wages and patient severity of illness. This study utilized the National Nosocomial

Infection Surveillance System (NNIS) protocols and Medicare files to measure patient outcomes. The NNIS, sponsored by the Centers for Disease Control (CDC), was a collaborative surveillance system that voluntarily reported and determined the magnitude of hospital-associated infections in the United States. Hospitals collected data by monitoring specific patients for infections with the use of protocols that contained surveillance components. The data collected was calculated to determine risk-specific infection rates that can be used by individual hospitals as well as national health-care planners to set priorities for infection prevention (Emori, et al., 1991). Nurses were identified as being primarily responsible for prevention of urinary tract infections and skin ulcerations (Stone, et al.). These were considered nurse-sensitive indicators. The authors also found that adequate nurse staffing was related to positive patient outcomes. Patient outcomes are what people notice and care about such as survival, symptoms, function, and health-related quality of life.

Curtin (2003) analyzed several research articles and determined that nurse staffing had a measurable impact on patient outcomes, medical errors, and mortality. Concerns about nurse staffing and nurses influence on patient safety and health care outcomes led to the measurement and reporting of nurses' performance (Needleman, Kurtzman, & Kizer, 2007). The American Nurses Association (2004), Nursing Safety and Quality Initiative became the foundation for the current method to measure nursing outcomes now known as the National Database of Nursing Quality Indicators (NDNQI). Established at the Midwest Research Institute in conjunction with the University of Kansas School of Nursing, pilot studies from 1997 to 2000 tested selected indicators and determined the current nursing quality indicators. The database served and continues to

serve as a depository for the evaluation of nurse-sensitive outcomes from hospitals in the United States and provided comparative reports to improve quality and safety (National Data Base of Nursing Quality Indicators (2010). The NDNQI database indicators of nursing care included items such as patient falls, health-care associated infections, restraints, registered nurse education and certification, and nursing hours per patient day. The NDNQI did not measure nurses' overtime or extended work hours as a nurse-sensitive performance measure; however, overtime may be an important indicator of the work environment since patient outcomes such as health-care associated infections have correlated with overtime (Stone, et al., 2007).

Trinkoff, Johantgen, Storr, Gureses, Liang, and Han (2011a, 2011b), in a study of 71 hospitals identified that work schedules related significantly to mortality when staffing levels and hospital characteristics were controlled. Pneumonia deaths were associated with hospitals where nurses reported working long shifts. Long shifts were defined as 13 hours per day or longer. Greater acute myocardial infarction or heart attack rates were associated with nurses that worked excessive hours per week and greater than their usual mean of 3.5 days in a row. Trinkoff, et al. stated, "Work schedule has an independent effect on patient mortality" (p. 6). The authors suggested that job demands and components of work schedules needed to be considered when determining how to improve patient outcomes.

Olds and Clarke (2010) provided a secondary analysis of anonymous surveys from 1999 completed by 13,152 staff nurses that worked in acute care hospitals in Pennsylvania. Data was collected on adverse events and included hospital-acquired infections, patient falls with injury, nurses injury at work, and medication errors. A

correlation was noted between nurses that worked more than 40 hours per week and an increased risk of adverse events. Voluntary paid overtime was associated with medication errors and needle stick injuries. Nurses who worked more than 40 hours were 28% more likely to report their patients received the wrong medication or dose as compared to those that did not work overtime. For each additional hour of voluntary paid overtime, medication errors increased by 2%. The mean overtime was approximately three hours per week. Although not as strongly related, nurses reported increased patient falls with injury and hospital-acquired infections when voluntary overtime was worked. A limitation of this study was that nurses were asked to self-report and remember the adverse events that occurred. In order to provide a mechanism for immediate reporting and maintain consistency with reported adverse events, The World Health Association under the World Alliance for Patient Safety drafted guidelines for adverse event reporting (Leape & Abookire, 2005).

Adverse Events

The fundamental roles of patient safety reporting systems were to enhance patient safety, learn from failures, and create an environment of action (Leape & Abookire, 2005). Reports were essential to prevent harm and save lives. Many, but not all adverse events that caused errors of commission or omission related to deficiencies in care systems. When large systems fail, it was often due to multiple faults that occurred together. Human error was one of those faults and one reason for adverse events (Leape & Abookire). Adverse event reports identified the individual that reported the event and provided structured classifications. Classifications, considered the first step in analysis, allowed for aggregate data collection. The use of spontaneous adverse event reports as

well as administrative data allowed for a robust understanding of adverse events (Agency for Healthcare Research and Quality, 2010).

The Joint Commission (2011b) in their sentinel event policy for hospitals encouraged the determination of potential improvement in processes or systems that decreased the likelihood of such events in the future. The science of patient safety encouraged the development of a culture of safety to avoid patient harm. Cultures of safety approached human fallibility by concentrating on the conditions under which people work and built defenses to avert errors (Reason, 2000). Santara Healthcare was an organization that utilized this approach to enhance safety. In a case study report by McCarthy and Klein (2011), Sentara fostered a culture of safety and reduced occurrences of harm. To achieve improvement, they examined their serious safety event rate. The definition of a serious safety event was a deviation from expected performance that resulted in moderate or severe harm to a patient. One initiative to improve performance focused on training frontline staff in error-prevention tools and behaviors. Sentara encouraged staff to use the acronym STAR (stop, think, act, review) as a reminder to focus and pay attention to detail. They also encouraged a questioning attitude through Validation and Verification. Peer checking was encouraged with a concept called Never leave your Wingman (Yates, et al., 2005). The development of a culture of safety including the use of these error-prevention tools reduced the measured rate of serious safety events by 80%, from a rate of 0.5 to 0.1 per thousand patient days over seven years (McCarthy & Klein).

As the largest healthcare workforce, nurses became responsible when healthcare standards were not met (Hughes, 2008). Therefore, it is necessary to understand the

complexity of the nurses work environment and improve the environment to perform safer patient care. Organizational work factors, considered the blunt end represented the majority of errors; however, clinicians were at the sharp end of errors (Reason, 1990). The sharp end resulting from human error required an awareness of nurse's cognitive strengths and weakness. Adverse events represented a cognitive phenomenon because errors reflected human cognitive action. When examining adverse events, human susceptibility to stress and fatigue influenced problem-solving abilities and resulted in errors at the sharp end (Reason).

Fatigue and Work Hours

A significant number of research studies confirmed beyond a doubt that fatigue impaired human performance (Belenky et al., 2003; Van Dongen & Dinges, 2005; Williamson et al., 2011,). Attentional lapses and brief moments of inattentiveness were the main reason for decreased cognitive performance from sleep deprivation. Research on chronic sleep deficit determined most adults required seven to eight hours of sleep to avoid fatigue and its accompanying performance deficits (Rosekind et al., 1997; Van Dongen, et al., 2003). Long work hours were associated with subjective fatigue symptoms (Park, Kim, Chung, & Hisanaga, 2001). Extended workdays were especially fatiguing if the workload was high, intense, or physically strenuous (Akerstedt, et al., 2002; Knauth, 1993; Knauth, 1996).

Scott, Hwang, and Rogers (2006) described fatigue and stress among nurses who provided care for older family members compared to nurses with or without children living at home. They looked at sleep duration and work performance based on caregiver status. A 28-day logbook was provided where nurses recorded work hours, errors,

sleep/wake patterns, perceptions of fatigue, alertness, stress, drowsiness, and sleep episodes. The study included 393 participants. Nurses who provided elder care obtained the least amount of sleep during the four-week period. There were a total of 199 errors and 213 near miss errors reported. Logistic regression allowed for the examination of the association between errors and near errors. Errors were 2.5 times greater among nurses who provided elder care at home; however, elder care was not associated with the risk of near errors. Fatigue and stress levels were the highest among nurses that cared for both children and elders. The authors suggested minimizing or eliminating overtime and applying circadian principles to hospital schedules to ensure a more alert workforce.

Dorrian, et al. (2008) conducted a research study of 41 full-time nurses in an Australian Hospital. The nurses for one month reported in a logbook scheduled and actual work hours, sleep length, sleep quality, fatigue, stress, exhaustion, nursing errors, and near errors. Nurses reported exhaustion, stress, and struggling to remain awake at work during one in three shifts. Sleep significantly reduced on workdays correlated with errors. Individuals who reported struggling to remain awake were nearly two and a half times more likely to make an error. “Interestingly, sleep was not significantly reduced prior to shifts where nurses recorded a near miss or caught someone else’s error” (Dorrian, et al., p. 610). The authors suggested further research to determine the effects of work schedules and sleep loss on patient safety.

In a study by Winwood and Lushington (2006), 760 nurses completed three questionnaires that determined work strain experienced by nurses. The questionnaires contained the Occupational Fatigue Exhaustion Recovery scale (OFER), the Questionnaire on the Experience and Evaluation of Work Demands (QEEW), and the

Pittsburgh Sleep Quality Inventory (PSQI). The results suggested a pattern in which work-related demands, sleep quality, and recovery resulted in maladaptive stress/fatigue outcomes. Psychological strain was more significant than physical strain and adversely affected both sleep and recovery.

A Japanese research study discussed the prevalence of excessive daytime sleepiness and sleep habits among 4,279 hospital nurses (Suzuki, Takashi, Kaneita, Yokoyama, & Uchiyama, 2005). The participants completed a questionnaire that used the Japanese version of the Pittsburgh Sleep Quality Index and described their experience over the last 12 months with drug administration errors, incorrect operation of medical equipment, and needle stick injuries. A statistically significant relationship over a 12-month period occurred between excessive daytime sleepiness and errors such as incorrect drug administration and incorrect medical equipment operation. An inverse relationship occurred between age and those who slept less than five hours. Age and needle stick injuries also directly related to sleepiness. “Excessive daytime sleepiness is an important occupational health issue in hospital nurses” (p. 451).

One of the main causes of sleepiness was sleep deprivation. This included too little sleep, fragmented sleep, circadian rhythm disruption, primary sleep disorders, and other medical conditions. (Office of Graduate Medical Education, Duke University Hospital, 2010). Belenky et al. (2003) studied daytime performance of 66 healthy volunteers with restricted sleep over seven consecutive days. Participants were restricted to various sleep durations over a 14-day period. Sleep durations included three hours, five hours, seven hours, and nine hours. Sleep restriction resulted in decreased psychomotor vigilance as measured by speed and lapses. Mild to moderate sleep deprivation of five to

seven hours resulted in an initial decline in performance after a few days, and then stabilized; however, with severe sleep restriction of three hours, performance decreased continuously with no stabilization. The daily minimum amount of sleep to avoid continued decrements in performance was four hours per night (Belenky et al.). Participants were then required to have eight hours of sleep on days 11 through 13. Performance recovery of the three, five, and seven hour sleep time participants was incomplete compared with the individuals who slept nine hours and demonstrated baseline performance (Belenky, et al.).

In a study of 48 healthy adults, Van Dongen, et al. (2003) randomized the participants to four, six, or eight hours of sleep per night for 14 nights or to zero sleep for three days. Participants in the four-hour sleep period displayed escalating numbers of lapses in alertness and decreased cognitive accuracy. Lapses in alertness were nearly linear to the cumulative duration of wakefulness. Chronic restriction of sleep to six hours or less per night resulted in cognitive performance deficits equivalent to approximately two nights of total sleep deprivation (Van Dongen, et al.). Nurses who worked successive 12-hour shifts slept an average of 5.5 hours between shifts (Trinkoff, et al., 2007). The nurses' adverse performance may be secondary to sleep deprivation, due to extended work hours and decreased sleep opportunity.

Johnson, Brown, and Weaver (2010) examined how sleep deprivation influenced psychomotor performance of staff nurses who worked the night shift. The d2 Test of Attention was given to 289 nurses five to nine hours into the assigned shift. Sleep deprivation was measured by a 48-hour sleep recall diary that reported the number of hours they needed to feel rested compared with the actual numbers of hours slept. Fifty-

six percent, or 162, nurses were sleep deprived. The mean hour of sleep for sleep-deprived nurses was 3.9 hours. There was an inverse relationship between psychomotor performance and hours of sleep. “Years of nursing experience, years of time on the night shift, and years worked on the unit had little influence on psychomotor performance” (p. 452).

Dawson & Reid (1997) determined that fatigue equated to alcohol intoxication. The cognitive performance of 40 participants was measured after they were kept awake for 28 hours. At another time, cognitive performance of the same participants was measured after consumption of 10 to 15 grams of alcohol every 30 minutes until their blood alcohol concentration reached 0.1%. Cognitive psychomotor performance using a computer test of hand-eye coordination was measured every 30 minutes for both events. The result with both events was decreased performance. At a mean blood alcohol concentration of 0.1% mean relative performance on the tracking task decreased on average by 11.6% (Dawson & Reid). “After 17 hours of sustained wakefulness cognitive psychomotor performance decreased to a level equivalent to that observed at a blood alcohol concentration of 0.05%” (p. 235). After 24 hours of sustained wakefulness cognitive performance was equivalent to a blood alcohol level of 0.1%. The effects of moderate sleep loss on performance were similar to moderate alcohol intoxication. Williamson & Feyer (2000) in their study reinforced the evidence that both sleep deprivation and blood alcohol concentrations produced impaired cognition and compromised performance of speed and accuracy needed for safe driving.

In a study by Scott et al. (2007) full-time staff nurses were asked to complete logbooks on a daily basis for four weeks. Of the 895 nurses that participated 596, or

66.6%, of the staff reported at least one episode of drowsy driving and 30 nurses, or 3.4%, of the nurses experienced drowsy driving every work shift. The one way commute time averaged 27.1 minutes; however, 67, or 7.5%, of nurses reported commute times greater than 60 minutes. The average hours worked was 11.92 hours. Nurses work hours exceeded 12.5 hours in 6,111 out of 11,334 shifts, or 53.8%, of all worked shifts. Participants averaged 6.7 hours of sleep per workday. The risk for drowsy driving doubled when nurses worked 12.5 or more consecutive hours and nurses who reported being drowsy slept an average of 6.33 hours (Scott, et al.). Almost two-thirds, 589, or 65.6%, of on duty nurses reported struggling to stay awake at work. In fact 151, or 16.9%, of nurses reported they fell asleep at least once during their work shift. Interestingly, 47%, or 970 out of 2,078 drowsy episodes and 28%, or 118 out of 415 sleep episodes occurred between the hours of 6:00 and 24:00. Nurses who reported drowsiness at work were more likely to struggle with driving home from work. Drowsiness posed a significant hazard to both the nurse and the general public. The researchers concluded that extended work hours increased the risk of drowsy driving and the potential for motor vehicle crashes (Scott, et al.).

In a large study of 2,737 residents in their first postgraduate year, 17,003 completed monthly reports (Barger, et al., 2005). The detailed reports provided information on work hours, work shifts, motor vehicle crashes, and near-miss incidents during the commute. Interns averaged 70.7 hours in the hospital weekly. The mean monthly number of extended shifts or shifts greater than 24 hours was 3.9. Although only 69%, or 1,888, interns drove to the hospital, reports confirmed 320 motor vehicle crashes occurred over one year. Every extended work shift scheduled in a month

increased the monthly risk of a vehicle crash by 9.1%. Of the 320 crashes, 131 led to emergency treatment, property damage greater than a thousand dollars, the filling of a police report, or a combination of these factors (Barger, et al.).

A pilot study conducted in Japan by Rogers, Holmes, and Spencer (2001) identified main factors that contributed to an increased level of sleepiness and associated driving impairment. The main factors included length of the sleep period prior to work, type of shift, and travelling time. Forty-two individuals involved in a road accident within the previous three years completed a questionnaire. “In this study one of the factors contributing to loss of sleep was long working hours: either over the short-term when a single duty exceeded 12 hours, or over the longer term, when duty hour exceeded 50 per week” (p. 135). In addition, the study showed that the average duration of sleep on the night shift was approximately one hour less as compared to individuals that worked day shift.

Long work hours were also a risk factor for shortened sleep (Virtanen, et al., 2009). In a longitudinal cohort study, over 2,000 British civil servants were asked to report the number of hours worked per day, the number of hours slept, and any sleep disturbances. Employees that worked greater than 55 hours reported sleep disturbances not previously present at baseline. The researchers concluded that long work hours were a risk factor for shortened sleep hours, difficulty falling asleep, and waking without feeling refreshed (Virtanen, et al.).

In a commentary to the Virtanen study, Gangwish (2009) confirmed that long worked hours were associated with sleep disturbances, but also identified concomitant behaviors that effect sleep such as alcohol, tobacco, reduced exercise, and increased food

consumption. Specific job characteristics in the work environment such as low work satisfaction and job performance also correlated with sleep disturbances (Kuppermann, et al., 1995). Many factors in addition to work hours contributed to fatigue, but the effects and risks of an extended work day and cumulative days of excessive work hours was of concern (The Joint Commission, 2011a).

Catastrophes such as the Space Shuttle Challenger accident correlated an adverse event relationship with irregular work hours and sleep deficit. Inadequate human response when there is a diminished capacity exaggerates the tendency for error, especially during circadian time zones of vulnerability (Mitler, et al., 1988). The risk of death from overwork extends to the individual employee as well. Karōshi, categorized as occupational sudden death, translates literally from Japanese as death from overwork (Nishiyama & Johnson, 1997). The Japanese Association of Industrial Hygiene (JAIH) established a Shift Work Committee to study the relationship between shift work and workers' health. The committee conducted a nationwide cross-sectional study using questionnaires and determined that workers who engaged in two-shift systems had more health problems. Later in 1982, the major approach to research on karōshi was an accumulation of cases and an emphasis on assembling proof of causality on an individual basis. This case study analysis indicated that karōshi deaths were associated with long working hours, shift work, and irregular work schedules. Most karōshi victims had been working long hours equivalent to more than 3,000 hours per year, just before death. The major medical causes of karōshi deaths were cardiovascular diseases (Nishiyama & Johnson).

Work Schedule and Occupational Injury or Illness

"The impact on health and safety of the combination of chronic sleep deficits and extended working hours has received worldwide attention" (Lombardi, Folkard, Willets, & Smith, 2010, p. 1013). In the United States, 74,415 individuals were randomly surveyed from 177,576 persons between the years of 2004 and 2008 (Lombardi, et al.). The purpose of the study was to determine the effect of total daily self-reported sleep time and weekly work hours on work-related injury. Over the five-year period, there were an estimated 3,634,446 work-related injuries and approximately 130 million workers at risk annually. Injury rates increased with decreased daily sleep. The categories of lowest sleep duration had higher injury risks. Sleep duration and hours worked were both associated with the risk of work-related injury, but there was not a significant interaction between the two. Reduced sleep resulted in increased injury while hours worked increased injury independently. The authors concluded that the most plausible explanation for the increased risk of work related injury was both work hours and reduced sleep (Lombardi, et al.).

Castro et al., (2010) examined the association between long work hours, shift work, and overtime hours with occupational injury and illness. At the 2007 Philippine Nurses Association National Convention, 655 Philippine nurses participated in the study. Occupational health outcomes were measured and included, back pain and work-related injury or illness in the past year. Findings indicated that nurses that worked outside of a day shift were at higher risk for occupational injury or illness. In addition, the more frequently a nurse worked mandatory or unplanned overtime, the greater the risk of work related injury or illness (Castro et al.).

Several studies confirmed a relationship between long work hours and illness or injury (Anderson & Buchholz, 1988; Gangwisch, et al., 2010; Kivimäki, et al., 2011; Lipscomb,Trinkoff, Geiger-Brown, & Brady, 2002; O'Brien-Pallas, et al., 2004; Vila, 2006). In a meta-analysis by Smith, et al. (1998), comparison of eight and 12-hour shifts did not identify greater problems with sleep or health. In other studies, work greater than 12 hours increased exposure to physical demands and reduced recovery time between work shifts (Waersted & Westgaard, 1991; Gangwisch, et al). Resultant illnesses or injuries included heart disease, obesity, high cholesterol, needle stick, back, neck, or shoulder injuries. In a study of 1,163 nurses, Lipscomb, et al. determined the prevalence of reported musculoskeletal disorders in 233, or 20%, of the nurses. Work greater than 12 hours per day, greater than 40 hours per week, weekends, and work other than day shift, was associated with a 50 to 170% increase in injuries to the neck, shoulder, and back. The schedule at highest risk for musculoskeletal injury was a combination of long worked hours and work other than day shift (Lipscomb, et al.).

In a longitudinal survey of 2,617 nurses, Trinkoff, Le, Geiger-Brown, Lipscomb, & Lang (2006) explored the relationship of the nurses work schedule and musculoskeletal symptoms that lasted longer than one week or occurred at least monthly. The authors found that the work schedule independently increased the nurses' risk of developing a musculoskeletal disorder not explained by physiological demands. Mandatory overtime and on-call practices directly linked to greater injuries. Decreased time off and workdays with less than 10 hours off provided fewer opportunities to recover (Trinkoff, et al.).

Employees that readily volunteered for additional work hours were not always aware of their fatigue levels; similar to findings found with alcohol intoxication (Van

Dongen, et al., 2003). “Workplace health and safety can be improved by reducing worker fatigue and risk” (Lombardi, et al., 2010, p. 1028). Several authorities recommended staff education as an intervention to prevent fatigue and its associated risks. (The Joint Commission, 2011a; Watkins, 2010). Education of fatigue risks and the utilization of fatigue countermeasures may change the culture of healthcare.

Fatigue Management Countermeasures and Education

Caruso and Hitchcock (2010) reported on strategies for nurses to prevent fatigue-related injuries. “Nurses, managers, and employers share the responsibility of implementing strategies to reduce sleep-related risks” (p. 193). Strategies for nurses included adopting good sleep habits, correcting causes of sleepiness, and providing enough time to sleep. Strategies for managers and employers included instituting policies and workplace systems to reduce fatigue. Specific strategies that reduced fatigue included the use of naps and work breaks during work shifts, effective caffeine utilization, light intensification, timing of demanding tasks, adequate nutrition, and scheduled work patterns (Caruso & Hitchcock; Hughes & Rogers, 2004).

In a study by Rogers, Hwang, and Scott (2004) data was obtained on work hours, errors, episodes of drowsiness, frequency of breaks, and actual sleep on duty from 393 nurses that completed a logbook for 28 days. Nurses reported when they took a break and if they were relieved of patient care duties during the break. Among the 5,211 shifts that were examined, nurses reported having no opportunity to take a break 534, or 10%, of the time and another 2,249, or 43%, of the shifts were reported as having the time to take a break, but not being relieved of patient care responsibilities. This meant that nurses were completely free from patient care responsibilities only 47%, or 2,429, shifts of which

40%, or 2,084, shifts exceeded 12 hours. This study had not identified any difference in the risk of errors reported by nurses who had a break free of patient care responsibilities compared with those that did not. Nurses reported that breaks averaged 23.8 minutes on shifts without errors and 16.2 minutes on shifts when errors occurred. Logistic regression showed a 10% decrease in the risk of making at least one error when nurses had an additional 10 minutes break resulting in a reduction of seven errors (Rogers, et al.).

Power naps as short as 20 minutes had not been found to be restorative in the workplace; however 30 minute naps decreased fatigue and sleepiness (Federal Aviation Administration, 2008). Smith-Coggins, et al. (2006) found that 40-minute planned naps in a sample of emergency department night shift physicians and nurses increased alertness. The ability to drive home improved; however, there was not sustained alertness. One suggestion was a more comprehensive fatigue countermeasure program.

In a study by Scott, Hofmeister, Rogness, and Rogers (2010b), hospital staff nurses and nurse managers that worked at least 36 hours per week participated in focus group sessions. These sessions followed the implementation of a fatigue countermeasures program for nurses (FCMPN). The FCMPN included fatigue management strategies that included provision of adequate staff, completely relieved breaks, and the use of strategic naps. The goal of the study was to gain insight into organizational and environmental factors that affected the feasibility of a hospital fatigue countermeasures program. “When asked about the benefits of the FCMPN, the staff nurses identified 3 overarching themes: an increased awareness of their own health and well-being as it related to proper sleep hygiene, increased restfulness and decreased fatigue, and greater confidence in their ability to control their own lifestyle issues that impact proper sleep hygiene” (p. 235).

In another study by Scott, Hofmeister, Rogness, and Rogers (2010a), 47 nurses who worked on medical-surgical units in three different hospitals participated in the FCMPN. The objective of the study was to evaluate the impact of the FCMPN on errors and drowsy driving. A conceptual model of impaired sleep used in this study, identified that sleep loss or poor sleep quality resulted from either sleep deprivation or sleep disruption. The method used was a prospective design that incorporated a pre- and posttest. Data collection occurred two weeks prior to the countermeasure program, four weeks after the intervention and three months later. The staff completed an educational program about fatigue, sleep and circadian rhythms. The program also included health effects associated with sleep loss or deprivation, and misconceptions about sleepiness. Highlights included strategies for managing alertness, minimizing fatigue, and maximizing sleep duration and quality. The program emphasized the use of naps and caffeine limitation. Institutional strategies included the ability to take uninterrupted breaks and strategic naps. The organization suspended policies that resulted in termination for sleeping on duty and provided sleeping accommodations for nurses that included a sleep recliner and 20-minute timer.

Logbooks were used to collect the information about hours worked, breaks, difficulty remaining awake, sleep-wake patterns, and errors or near-errors. Before the FCMPN intervention, nurses reported the mean sleep duration on workdays as 6.81 hours with a range of 1.50 to 9.73 hours. Nurses reported a significant increase in total sleep obtained in the four-week period after the FCMPN and continued to obtain increased sleep at 12 weeks after the intervention. Nurse participants increased sleep by an average of 50 minutes and the minimum amount of sleep time on work days increased to 3.77 at

four weeks post-intervention and 3.38 hours 12 weeks post intervention. In addition, post-intervention errors and near errors decreased (Scott, et al.).

Nurses must be knowledgeable about the potential for fatigue related error and injury and minimize the number of successive shifts to reduce cumulative sleep deficit (Akerstedt, 1985). The growing trend of personal short sleep durations may be related to a lack of knowledge about sleep. “Nurses, managers, and employers often lack an appreciation and knowledge about the risks linked to worker fatigue, and do not have systems to address these risks” (Caruso & Hitchcock, 2010, p. 196). In 2008, The Joint Commission in their proposed safety goals encouraged hospitals to identify and educate workers on fatigue; however, the latest 2013 Joint Commission national patient safety goals did not require employee fatigue education (The Joint Commission, 2013). In a 2011 sentinel event alert, The Joint Commission explained the risks of an extended workday and cumulative days of excessive work hours and presented suggested actions. This included the development of a fatigue management plan that highlighted scientific strategies or countermeasures. Education regarding sleep hygiene and the effects of fatigue on patient safety were recommended, but not mandated.

The State of Wisconsin vs. Thao (2006) case sparked the Wisconsin Hospital Association to develop written principles that related to healthcare work environment and fatigue. These principles stated the responsibilities of the employer included ensuring employees be informed about fatigue risks. Employers must also provide direction on how to control these risks. Employees should report problems with fatigue, recognize fatigue symptoms, and manage individual factors that affected fatigue. Wisconsin health care employers were responsible to inform employees about fatigue risks and

countermeasures to control risks; however, other states had not followed these principles (Wisconsin Hospital Association, n. d.).

Tabone (2004) suggested a bundle approach to strategies known to decrease fatigue. These included established scheduling practices with maximum hours worked per day and per week, the establishment of rest places, science of sleep and risk associated fatigue education, and approaches to circadian rhythm disturbances. The Canadian Nurses Association also recommended professional development and clinical courses that incorporated information about the impact of fatigue on clinical work, lifestyle, and health (Tabone). In today's technological society, educational programs have expanded beyond the classroom with professional development and courses presented in a web-based format. Several studies have demonstrated that web-based instruction was more effective than classroom instruction (Wisher & Olson, 2003; Sitzmann, Kraiger, Stewart, & Wisher, 2006). Therefore, the utilization of web-based training can be used as a methodology for fatigue management countermeasure education.

The need for fatigue education for medical residents gained recognition in 2003 by the development of the Sleep, Alertness, and Fatigue Education in Residency (SAFER) taskforce (Owens, et. al., 2003). The taskforce identified that work hour regulations was not sufficient to achieve the goal of adequate rest and optimal performance. The taskforce members stated, "Education is necessary to effect any substantial and sustained behavioral change on the individual level (i.e., the individual needs to understand the rationale for the changes in order to "buy into" them, and also accepts personal responsibility for instituting them" (p. 1). Education was considered the

vehicle for affecting lifestyle or personal behaviors that impacted fatigue and alertness. The taskforce prepared an educational module that discussed sleep deprivation experienced by all task force members during residency. The power point program included principles of sleep, the impact of sleep loss and fatigue on medical residents' mood, work performance, medical education, and medical errors. It also presented myths and misconceptions about fatigue and strategies that addressed the management of sleep loss and fatigue (Owens et al.).

The Office of Graduate Medical Education, Duke University Hospital (2010) required program directors to include discussions on adherence to duty hour requirements, minimization of prolonged work, adequate sleep requirements, sleep debt and resident safety that included driving home. They also encouraged resident involvement in the implementation of fatigue countermeasures. The Accreditation Council for Graduate Medical Education (2011) required education of faculty and residents in fatigue recognition and duty hour requirements to counteract the potential negative effects of sleep deprivation. The education emphasized the physician's professional responsibility of fitness for duty in the promotion of patient safety and resident well-being. They were encouraged to recognize impairment, including illness and fatigue. The Federal Aviation Administration (2010c), proposed fatigue training for all air carrier pilots included five hours of initial training followed by two hours annually. The requested training curriculum included education on flight duty and rest, sleep fundamentals, circadian rhythms, and medical conditions that can cause fatigue. Performance, fatigue countermeasures, and lifestyle influences were a component of the program as well. The training stressed individual accountability to prevent fatigue.

To assist with the development and review of fatigue mitigation strategies, Fatigue Risk Management Teams (FRMT) developed within individual airlines as part of a safety management system. The team was also responsible for the quality assurance of initial and recurrent fatigue risk management training (Gunther, 2008). The Aerospace Medical Association Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee developed fatigue countermeasure position statements that utilized scientific studies that supported their position (Caldwell, et al., 2009).

The position paper on fatigue countermeasures in aviation included subjects such as crew rest and duty time recommendations. They also addressed in-flight countermeasures that included cockpit napping, activity breaks, and cockpit lighting as well as pre and post flight strategies such as sleep optimization, shift schedules, medications, and the restriction of Federal Aviation Administration regulated substances. Mathematical models to predict performance included fatigue scheduling software and a wrist-worn actigraph, also known as a sleep watch designed to assist with fatigue management (Balkin, et al., 2004; Hursh, et al., 2004). “There are tools that can be effectively incorporated into overall safety management approach, and should not be used in place of regulatory limitations” (Caldwell et al., 2009, p. 48). The Department of Transportation, Federal Aviation Administration (2010) supported a structured comprehensive plan for fatigue mitigation that included senior level management commitment, fatigue management reporting policies, duty time limitations, a rest plan, and awareness training. The Committee on Work Environment for Nurses and Patient Safety (Page, 2004), a subset of the Institute of Medicine, in their proposed work hour

guidelines recommended nurses be educated on the effects of fatigue on patient safety. To date, no educational fatigue programs are required for nurses.

Conclusion

Patients deserve quality care from alert, competent nurses. “Registered nurses are indispensable to healthcare; yet fatigued nurses put their patients at risk” (Scott, et al., 2010b, p. 239). Fatigue resulted in slowed reaction time, lapses of attention to detail, adverse events, omissions, and decreased energy, all of which affected the care provided. The evidence strongly suggested that extended-duration work shifts and excessive work hours significantly increased fatigue and decreased performance. The reported number of deaths from healthcare errors sounded an alarm to alert healthcare professionals and the public. This alarm must be answered. The healthcare environment must be transformed into a safe haven versus a hazardous milieu. Other safety-sensitive industries have acknowledged these issues and taken action. Further nursing research studies are needed to consistently provide and maintain a culture of safety. In order to promote safety, the following research questions were examined.

RQ1 – What impact did work hour guidelines and fatigue education have on the implementation of fatigue management countermeasures?

In development of a culture of safety the major focus had been on system redesign; however, understanding human error must be included. Regardless of how well systems worked, individuals remained fallible. This human fallibility required a defense mechanism to avert errors and avoid harm.

Human fatigue contributed to major disasters and errors. Errors reflected a lapse in cognitive function and resulted in fatigue impaired psychomotor responses. Fatigued

nurses reported difficulty staying awake and actually fell asleep while on duty. Fatigue decreased performance and severe sleep deprivation was equivalent to alcohol intoxication. The consequences of drowsy driving included significant hazards to the individual and the public. Work greater than 12.5 hours and sleep that averaged six hours resulted in drowsy driving. Chronic sleep deprivation of less than six hours per night resulted in performance deficits. Long work hours, overtime, and working multiple days in a row increased fatigue levels and in some cases resulted in death from being overworked.

To decrease fatigue and improve safety, countermeasures included strategic napping, sufficient sleep, work breaks, and work hour restrictions. Safety management techniques also included the use of error prevention tools, but it was unknown if these tools were more frequently utilized when fatigued. Education of fatigue countermeasures was standard for medical residents and the aerospace industry; however, was not traditional education for nurses despite recommendations by the Institute of Medicine and The Joint Commission. Since fatigue education was not previously required, the nurses' actual usage of fatigue countermeasures was unknown.

RQ2 – What impact did work hour guidelines and education have on hours worked?

The work schedules of nurses violated the Institute of Medicines' work hour recommendations for patient safety. Many nurses worked extended hours, had more than one job, worked overtime, and did not leave promptly at the end of their shift. Reported nurse work shifts were as long as 23 hours and 40 minutes. The position statement of the American Nurses Association claimed that the employers role was to provide scheduled

work hours that promoted rest and recuperation; however, each nurse must consider their fatigue level upon acceptance of the work schedule. These American Nurses Association proposed guidelines were non-existent in the workplace as exemplified by the above examples of excessive work hours. Currently there are no federal work hour regulations for nurses and state regulations are only minimally restricted. Work hours became the responsibility of the individual nurse who often worked extended shifts and successive days in a row. Work hour regulations occurred in other safety-sensitive industries, but not in nursing. Personal work-hour commitments to achieve safety remained a challenge. Even after the death of a patient impacted by long work hours, residents worked beyond their allowable hours. It was unknown if the implementation of work hour guidelines and education of nurses would result in a change in actual work hours. A self-report of work hours at all jobs was needed to determine if work hour guidelines and education changed total work hours.

RQ3 – What impact did the implementation of work hour guidelines and education have on adverse safety events?

Hundreds of thousands of patients were subjected to adverse safety events. The implementation of stricter medical resident work hours resulted in decreased adverse safety events; however, this correlation for nurses had not been studied. A decrease in work hours for medical residents increased sleep and decreased attentional failures as confirmed by electroculography. Errors increased after nine hours of work and were three times higher when nurses worked 12.5 or more hours. Adverse safety events that included medication errors correlated with nurse work hours greater than 40 per week. Fatigued related adverse events also increased with the number of extended hours due to

limited sleep opportunity. When medical residents decreased their work hours, sleep increased. Nurses with attention to detail have demonstrated the potential to mitigate errors and protect patient safety. Current literature did not address the implementation of work hour guidelines and its affect on adverse safety events.

RQ4 – What effect did the implementation of work hour guidelines and education have on nurse-sensitive patient outcomes?

Nurses that worked greater than 40 hours per week had a greater risk of adverse events. Productivity decreased with multiple consecutive worked shifts. Adverse patient outcomes occurred when nurses worked extended hours and successive days greater than three in a row. Nurses should be responsible for primary prevention and the development of nurse-sensitive indicators that measure and evaluate patient outcomes directly affected by nursing care.

Fatigue is a serious issue. The current research study looked at the effects of education and work hour guidelines on current hospital nursing staff working in 24-hour patient care units. Fatigue prevention must become an everyday reality in the nursing profession. If left untouched, the mind will lose control and sleep becomes the winner (Printup, 2000).

CHAPTER III

METHODOLOGY

Introduction

The work hours of registered nurses were of concern since nurses provided the bulk of direct hospital care vital to maintain the safety of patients (Rogers, 2004). Nurses frequently worked overtime in excess of 12 hours per day and more than 50 hours per week (Rogers, et al., 2004; Trinkoff, et al., 2006). Excessive work hours and shifts greater than 12 hours per day provided limited opportunity for nurses to sleep (Scott, et al., 2007, Virtanen, et al., 2009). Fatigue from limited sleep resulted in diminished work performance capacity and impaired alertness (Rosa, 1991). Medical errors increased after nine hours of work and tripled after 12.5 consecutive work hours (Hänecke, et al., 1998; Rogers, et al., 2001; Rogers, et al., 2004). To promote safety, education and fatigue management programs were recommended; however, the existence of these programs in nursing was currently limited (The Joint Commission, 2011a; Watkins, 2010; Caruso & Hitchcock, 2010). Strategies to enhance safety in other professions included education, fatigue management countermeasures, and restricted work hours. Currently, the One Day Rest in Seven Law enacted by a few states only minimally restricted nurse work hours (Department of Labor, State of Illinois, 2003).

Through an examination of nurses work hours, this study sought to promote patient safety. The purpose of this study was to determine if work hour guidelines and education regarding safety risks had an impact on nurses excessive work hours, fatigue

management practices, and patient outcomes. The following questions were addressed utilizing the methodology explained below:

1. What impact did work hour guidelines and fatigue education have on the implementation of fatigue management countermeasures?
2. What impact did work hour guidelines and education have on hours worked?
3. What impact did the implementation of work hour guidelines and education have on adverse safety events?
4. What effect did the implementation of work hour guidelines and education have on nurse-sensitive patient outcomes?

Research Design

The research design was one of ex post facto since the research hospital had already implemented a pre-intervention written survey in response to a medication safety event related to excessive work hours. At the research hospital, the interventions of work hour guidelines and education followed the initial survey. A control hospital was also included and had not previously completed the survey nor implemented work hour guidelines and education. This design resulted in three actual survey groups:

Group I - Research hospital nurses, pre-intervention

Group II - Research hospital nurses, post-intervention

Group III - Control hospital nurses, no intervention

Since a code was present on the survey, there was an opportunity to identify nurses that participated in both the pre-intervention and post-intervention survey at the research hospital. This represented a fourth group; however, these participants were actually a subgroup of Group I and Group II.

Group IV – Research hospital nurses, pre-intervention and post-intervention

All groups met the inclusion criteria of the study.

At the research hospital, the same pre-intervention survey questions administered to Group I were also completed post-intervention (see Appendix A). The post-intervention survey added one question to confirm nurses completed the educational program (see Appendix B). This was consistent with a pre-posttest design (Leedy, & Ormrod, 2010). Nurses at the control hospital completed the same survey questions (Appendix C). The principal investigator collected the retrospective quantitative data that pertained to work hours, patient safety events, and quality outcomes at both the research and control hospitals.

The study design was ex post facto, since the event had already occurred and the conditions that were present had a possible relationship to the dependent variable of interest (Leedy & Ormrod, 2010). In this study, the principal investigator was instrumental in the development of the research hospital's implementation plan to prevent medical errors related to work hours. The implementation plan contained two independent variables identified in this research study. One independent variable was the introduction of a computer-based safety education program. The principal investigator, a nurse educator of 30 years, developed the computer-based education program because a safety education program for nurses related to work hours was not readily available. This computer safety program provided education on the risk of medical errors associated with extended work hours and included fatigue countermeasure techniques. Several studies demonstrated that computer program instruction was more effective than classroom instruction (Wisher & Olson, 2003; Sitzmann, et al., 2006); therefore, computer-based

instruction was chosen. The computer-based program also allowed for consistency in the delivery of information. Fatigue management educational programs had been developed and mandated in medical education and in aviation; however, had not been a requirement for nurses. These previous programs became the foundation for the development of this educational program. Various video clips developed by experts on fatigue were obtained with permission and included in the educational program. The computer-based education program was also reviewed for content input by educators, administrators, human resource management, and safety experts at the research hospital. Administration mandated that nurses in 24-hour patient care units at the research hospital view the training program. The launch of this program occurred following the completion of the initial survey.

The second independent variable, work hour guidelines, were developed by the hospital safety committee and approved by administration. The work hour guidelines included a maximum of three twelve hour shifts in a row and no greater than 100 hours of work in a two-week pay period. The research hospital's Human Resource Department approved the guideline; however, the guidelines did not become policy subject to disciplinary action if violated. Nurse managers were encouraged to implement the guidelines in their department; however, there was no recourse if the guidelines were violated. Managers reviewed monthly schedules in advance to minimize pre-scheduled workdays to no more than three 12-hour shifts in a row. At the research hospital, the introduction of the two independent variables, work hour guidelines and education occurred at the same time.

At the research hospital, the initial written survey, education program, and work hour guidelines occurred under the direction of the hospital safety committee. The initial nurse surveys, Group I, collected throughout August of 2011, reflected nurse work hours of June and July, two months prior to the survey. Mandatory computer safety education for the research nurses occurred in September of 2011 and extended into October for those that were not compliant in completing the computer-based education program in September. During the month of March 2012, both the research and control hospital nurses, Groups II and III, completed the same survey questions. This survey reflected nurse work hours during the months of January and February 2012. The surveys were voluntarily completed during work hours that included various times of the day and night. The surveys were hand collected within the same work shift.

To examine the first research question, registered nurses at the research hospital were asked to complete a written questionnaire regarding fatigue management countermeasures prior to and following fatigue education. Since such a tool was not obtainable and the hospital requested a quick response to address the recent medication safety event, the primary researcher developed the questions pertaining to fatigue countermeasures. No similar survey of fatigue countermeasures that demonstrated reliability and validity was found in the literature. Retrospectively, a reliability analysis of the fatigue countermeasure questions for Group I was conducted. Reliability data using Cronbach Alpha for analysis was available on 146 complete cases pertaining to the fatigue countermeasure questions (see Table 1). Missing data was calculated at 3.7%.

Table 1

Group I - Cronbach Alpha Case Analysis

Group I Cases	*n*	%
Valid	146	69.5
Excluded[a]	64	30.5
Total	210	100.0

[a] List wise deletion based on all variables in the procedure.

A Cronbach Alpha result for Group I of .68 identified the degree of internal consistency of the items asked (see Table 2). This was below the acceptable .70 in social science research.

Table 2

Group I – Cronbach Alpha Result

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
.679	.680	12

Only two of the twelve questions had a Cronbach Alpha lower than 0.70; however, the elimination of these questions did not increase the Cronbach Alpha result (see Table 3).

Table 3

Group I – Cronbach Alpha Question Analysis

Survey Question on Fatigue Countermeasures Reflecting the Previous Two Months (*n* = 146)*	Mean	Std. Deviation
Slept at Least Six Hours	2.8836	.81799
Slept at Least Eight Hours	2.1644	.82234
Took Naps when Drowsy	2.2808	.82832
Restricted Work Hours to 50 Hours per Week	3.0479	.83321
Limited Days in a Row Work Schedule	2.9589	.93127
Limited Caffeine Intake Prior to Sleep	2.6507	.97974
Took a 30 Minute Break at Work	2.4452	.90234
Utilized Wingman Concept when Fatigued	2.5000	.79871
Utilized Stop, Think Act, Review when Drowsy	2.9178	.70961
Utilized Qualify, Validate, Verify when Fatigued	3.0205	.61554
Followed a Set Schedule	2.5137	.93393
Identified Coworkers without Rest	3.0479	.64682

Note. *Missing data reduced surveys available for analysis

A Cronbach Alpha was also determined from the results of the control hospital nurses, Group III, that completed the identical questions. Cronbach Alpha for this group measured 0.67.

Following IRB approval, registered nurses who met inclusion criteria, worked at the research hospital, participated in work hour guidelines and education completed the

same written survey that included fatigue countermeasure techniques. This created Group II. Fatigue countermeasure data obtained via the written survey formulated a basis for comparison. Group IV data provided same group comparison on fatigue countermeasures.

At the control hospital following IRB approval, registered nurses in 24-hour patient care units that met inclusion criteria, Group III, completed the same survey that included fatigue countermeasures. The control hospital did not execute work hour guidelines or complete the safety education program; however, they did complete the survey throughout the month of March of 2012. This was the identical month that the research hospital nurses, Group II, completed the same post-implementation survey. This survey reflected the prior two months of January and February 2012.

To answer the second research question, all surveys given to nurses at both the research and control hospitals asked the nurse's perception of the typical number of hours they worked in a day. The questionnaire also inquired about their perception of the typical number of hours worked in the last two months at their primary job and at a secondary job if applicable. For further analysis of the second research question, schedules at the research and control hospitals determined the actual number of 12-hour shifts worked in a row. The months examined correlated with the same months reflected on in the survey, June and July 2011, as well as January and February 2012. Additional reports obtained through the Human Resource Department identified the number of nurses that worked greater than 100 hours in a two-week pay period at both the control and research hospital. Obtained data was for the months of June and July 2011 at the

research hospital as well as January and February 2012 at both the research and control hospitals.

To answer the third research question and measure the impact of work hour guidelines and education on patient safety, adverse events collected by risk management that reflected nursing care were examined. The primary researcher determined the recorded events that reflected nursing care and a second registered nurse verified the findings. All discrepancies were resolved through discussion. At the research hospital, the adverse patient safety events for June and July 2011 and again for January and February 2012 formulated the data for analysis. This period correlated with the survey data. Also reviewed were adverse patient safety events at the control hospital during the months of January and February 2012. Safety events that reflected nursing care were also categorized and identified by level of harm. The level of significance included no harm, minimal harm, treatment required, increased level of care required, and death. The risk management nurse determined the level of significance identified by strict definitions. For the purpose of the research study, summation of the level of harm resulted in two levels of safety events, those that caused harm and those that did not cause harm.

The final question determined the impact of work hours on nurse-sensitive patient quality outcomes. Quality outcomes assessed included patient falls and the development of hospital-acquired skin ulcers. Each hospital employed a wound care nurse that collected data on hospital-acquired skin ulcerations, a reflection of the quality of nursing care. Research question number four compared patient outcomes for skin ulcerations over a two-month period prior to and following the implementation of work hour guidelines and computer safety education. Again, the months studied were June and July

2011, and January and February 2012. The control hospital also collected skin ulceration data using the same criteria extracted over the same post-implementation period of January and February 2012. Patient fall data was examined using the NDNQI database for the identical study months at both the research and control hospitals.

This quantitative research study looked at the effect of work hour guidelines and education on fatigue countermeasures, hours worked, adverse patient events, and nursing quality outcomes. The study also used a quasi-experimental design since there was no randomization of subjects and the collection of data allowed for a pretest-posttest comparison of the research group (Salkind, 2009). Data obtained via nurse surveys and various hospital reports reflected fatigue countermeasures, work hours, adverse events, and nurse-sensitive quality outcomes. The design also included a comparison of the research and control hospitals.

Population

The research study used a purposive sample of clinical nurses at two designated hospitals located in the Midwest. The hospitals were both private not-for-profit institutions under the same ownership located in the same suburban county. The generated hospital reports and survey methods were comparable since the hospitals were a component of the same corporate structure.

Inclusion criteria incorporated clinical nurses that worked in departments that had 24-hour patient care responsibilities. Excluded from the study were nurses in non-clinical roles such as administrators, educators, managers, quality, and care coordination. Also excluded were clinical nurses in departments who were required to report for emergencies. A matched code in the survey provided data from nurses employed

throughout the entire research study; however, all nurses in these departments may have contributed to the adverse safety events and nurse-sensitive quality outcomes.

During the initial months of the research project, there were 299 eligible nurses employed at the research hospital in 24-hour patient care units. In August of 2011, 210 nurses, or 70.2%, of the eligible nurses participated in the initial pre-implementation survey. This formulated Group I. Six months later, there were 312 nurses working in the 24-hour patient care units at the research hospital. In order to participate in the study at this point, the nurses were required to complete the computer-based safety education program. The eligible number of responding nurses for the study at the research hospital decreased to 304 because eight nurses returned the survey and stated they had not viewed the required education. In March of 2012, 196, or 64.5%, of research hospital nurses, also known as Group II, completed the post-implementation survey. Using a deidentified code, the pre-implementation survey matched with the post-implementation survey resulted in 80 nurses. A potential of 180 eligible research hospital nurses participated in both surveys. Of the 180 eligible nurses, 80 identification codes on the surveys were matched for a total of 44.4% of eligible nurses, referred to as Group IV. During the month of March 2012, there were 483 eligible nurses at the control hospital. Of the eligible number of nurses, 191, or 39.5% completed the same survey, referred to as Group III.

Table 16 represents the demographics of these four groups, Table 17 represents educational information, and Tables 18 represents work information. The completed surveys were the source for this information. The appendices reflected the fact that not all participants answered each question. Group IV represented the research hospital nurses

that participated in the entire study. They participated in the pre-intervention survey, the intervention of work hour guidelines and safety education, and the post-intervention survey. The survey determined that in Group IV, 76, or 95%, of the nurses were female and 4, or 5% were male. In comparison, the national average of male nurses was 5.4% (Minority Nurse, 2010). The great majority of nurses in Group IV, 63, or 79.7% were Caucasian, with the next highest group 13, or 16.5%, of Asian descent. Only three nurses who participated, 3.9%, were of minority status outside of Asian for a total of 16, or a 20.4% minority participation. One nurse did not answer the question regarding race. In comparison, the United States Census (2010) determined that in the US 223,553,265 people, or 72.4%, were white. By definition, white included respondents who reported entries such as Caucasian or White; European entries, such as Irish, German, and Polish; Middle Eastern entries, such as Arab, Lebanese, and Palestinian; and North African entries, such as Algerian, Moroccan and Egyptian (Hixson, Hepler, & Kim, 2011). Asians were considered a minority in the US Census Bureau statistics.

The majority of nurses, 44, or 55%, in Group IV obtained a bachelors degree and, 70, or 87.5%, were educated in the United States. The majority, 51, or 63.7%, had greater than 10 years of experience as a registered nurse. The survey also asked the nurses their employment status related to work hours. Full time nurses in Group IV totaled 58, or 72.5%, and part time nurses totaled 20, or 25%. There was also a category labeled other reported in Table 18. This status required the nurses to work a minimum of eight hours per month. These nurses personalized their work schedule in conjunction with the work needs of the hospital. This consisted of 2 nurses, or 2.5% of the nurses surveyed in Group IV.

Scheduled hours of the majorly of the nurses, 70, or 87.5%, consisted of 12 hour shifts; therefore, the twenty-four hour work day was mostly split into two shifts. The day shift was worked by 33, or 41.3% of the participants, and 38, or 47.5% of the participants in Group IV worked the night shift. Shift is an important demographic because statements by nurses when filling out the survey included, “You should give it to the night shift, not the day shift”. Such personal statements confirmed the lack of knowledge that daytime sleepiness is an important occupational health issue (Suzuki, et al., 2005). Greater awareness of the need for occupational health was especially important since 19, or 24.1% of the nurses in Group IV had an additional job.

Since research studies identified that the additional responsibility of caring for children or the elderly decreased sleep and increased fatigue, data was obtained about family responsibilities (Scott, et al., 2006). Only 15, or 19%, of the nurses in Group IV, reported not being responsible for the care of children or other adults such as parents. In the same survey, nurses reported that 37, or 46.8%, were responsible for a significant amount of care for adults and 46, or 58.2% provided care for children (see Table 19). This information was a confounding factor in fatigue; however, this information does not specifically answer any of the proposed research questions.

Data Collection

IRB approval was obtained from both the university and the hospital corporation acting as the umbrella for both the research and control hospitals. The IRB also approved the utilization of two additional nurse data collectors that participated in distribution and hand collection of the written survey. One nurse worked at the research hospital, the other at the control hospital. Both data collectors participated in survey collection at their

employed hospital. The primary investigator of the research study distributed and hand collected the written surveys and obtained data on actual work schedules, safety events, and nurse-sensitive patient outcomes from both the control and research hospitals. Data collected by the primary investigator on patient volumes demonstrated a variation in the hospitals. Institutional Review Board (IRB) approval allowed retrieval of hospital data ex post facto and approved additional data collection post-implementation.

The initial research hospital survey (see Appendix A) distribution occurred throughout the month of August in 2011 to Group I. The survey was hand delivered to registered nurses while they were on duty or at a meeting and returned to the data collector the same shift. Group II at the research hospital completed the same questions in the post-implementation survey (see Appendix B). The written survey distribution for Group II occurred throughout the month of March 2012, six months following the initial survey. Six months was chosen to minimize reactivity from the educational program and work hour guidelines. Reactivity occurs when participants in the study know the intent of the study (Salkind, 2009). To provide consistency, the control hospital, Group III, also completed the same survey questions (see Appendix C) during the month of March 2012.

All of the hand delivered written surveys reflected work hours and fatigue countermeasures two months prior to the survey. The survey completed in August reflected June and July 2011and the March survey reflected January and February 2012. This period avoided the winter holiday work hours that may be an atypical representation. Data obtained on work hours, adverse safety events, and nurse-sensitive indicators reflected these periods.

The demographic data was obtained through the written survey provided to nurses in the 24-hour patient care units at both the research and control hospitals. Several of the demographic survey questions were adopted with permission from the National Samples Survey of Registered Nurses sponsored by the United States Department of Health and Human Services (2008). This survey had been conducted about every four years starting in 1977. The objective of this national survey was to sample and estimate the characteristics of the registered nurse workforce. The occupational employment statistics survey included approximately 6.7 million in scope and provided probability sampling of approximately 200,000 semiannually. According to the Survey Methods and Reliability Statement for the May 2011 Occupational Employment Statistics Survey (United States Department of Labor, Bureau of Labor Statistics, 2011), several edit and quality control procedures were used to reduce nonsampling error; however no formal psychometric testing was performed. The survey authors conducted cognitive testing during the instrument design phase. Not all questions asked in the national survey pertained to this research study; therefore, only applicable questions were utilized.

In the surveys developed for this research study (see Appendices A, B, C); nurses who met the study criteria also rated their fatigue mitigation behavior through use of a four point Likert scale. The Likert scale consisted of a one to four range with one being strongly disagree and four being strongly agree. Rating scales are utilized when a behavior or attitude needs to be evaluated on a continuum (Leedy & Ormrod, 2010). The survey reflected key behavioral fatigue countermeasures presented in the computer-based safety education program.

A survey pilot occurred consisting of 17 clinical nurses that worked in the 24-hour departments. Following the pilot, questions were modified to increase clarity. Data from the nurses that participated in the pilot was not included in the analysis. The survey was also reviewed by hospital safety experts and human resource management.

Research study participants were provided written information on the study procedure, risks, benefits, confidentiality, and the right to voluntary participation. The nurses that voluntarily participated in the initial survey at the research hospital, Group I, were asked if they would like to be entered into a drawing. Coffee gifts certificates, one per 24-hour patient care unit with a value of $10.00 each were raffled off to participants that placed their name on a separate list. Not all survey participants opted to place their name on the list. The distribution of the coffee certificates to the winners occurred prior to the introduction of the post-intervention survey. There were no incentives for the post-intervention survey at the research hospital and individual wrapped candy was the only incentive provided to nurses at the control hospital. The survey investigated the dependent variables of perceived hours worked, perceived hours worked at additional jobs, and implemented fatigue countermeasures.

In order to answer the remaining research questions, additional investigated nurse-sensitive dependent variables included actual work hours, patient safety events, and patient quality outcomes. Nurse participation was determined for each of these categories. Work schedules reviewed by the principle investigator from a computer program determined the actual number of days worked in a row. The computer program was monitored by the staffing office. The number of employees with work hours greater than 100 hours per pay period was obtained from the Human Resource Department.

Automated work time sheets obtained reflected actual work hours greater than 100 hours per pay period. The patient safety events were obtained from the Risk Management Department's computerized program. This data was collected from individual adverse event reporting. The events were already categorized into adverse outcomes, blood products, treatment delays, diagnostic labs, medical records, medication events, and system failures. Data regarding nurse-sensitive outcome data was obtained from the Quality Department.

Analytical Methods

Data collected was entered into a Statistical Package for the Social Sciences (SPSS) software program for analysis. Calculations by hand or via the computer were also performed in cases of simple statistics. *Z* scores were calculated using the DataStar, DataStat computer program. The research questions were approached with the following analytical methods.

RQ1 - What impact did work hour guidelines and fatigue education have on the implementation of fatigue countermeasures?

Prior to fatigue countermeasure education and six months later following education and work hour implementation, clinical nurses at the research hospital who met study criteria voluntarily completed the survey that included fatigue countermeasures. A comparison of the utilization of fatigue countermeasures was measured via a Liket scale and analyzed by group, category, and individual elements. Nurses at the control hospital also completed the fatigue countermeasure survey; however, they did not implement work hour guidelines or the educational program. Analysis of Groups I, II, and III was performed using ANOVA. Following ANOVA, a Tukey post hoc test provided

comparisons that allowed for the identification of differences between individual pairs. Analysis of Group IV consisted of dependent *t*-tests.

RQ2 - What impact did work hour guidelines and education have on hours worked?

The survey also provided self-reported data on hours worked. Categorical data of the groups was analyzed using crosstabs/chi-square. Analysis for self-reported nominal data utilized ANOVA followed by Tukey post hoc to determine group comparisons. Analysis of paired samples included dependent t-tests. Hospital payroll reports and schedules determined the nurses actual work hours. Analysis of these categorical work hours included crosstabs/chi-square.

RQ3 - What impact did the implementation of work hour guidelines and education have on adverse safety events?

This research study also looked at the number of adverse safety events that occurred at the research hospital prior to and following work hour guideline implementation and education. The number of adverse safety events at the control hospital was also collected. Categories examined for this data collection represented clinical nurse involvement. Categorical data was analyzed using crosstabs/chi-square. Patient volumes differed between the research and control hospitals; therefore, a *z* score that included proportional data for adverse events was completed. Reported safety event data also included categorization by level of significance. Summation of these levels into two groups, harm and no harm, was analyzed using crosstabs/chi-square.

RQ4 - What effect did the implementation of work hour guidelines and education have on nurse-sensitive patient outcomes?

The identified hospitals collected monthly information on nurse-sensitive patient quality outcomes. In a study by Stone, et al., (2007), increased overtime was associated with higher rates of skin ulcerations. The wound care nurse collected this nurse-sensitive patient outcome data. Patient outcomes for skin pressure ulcers reported as a rate per 1,000 patient days compared a two-month period prior to implementation of work hour guidelines and safety education in the study hospital and two months following implementation. The control hospital also collected skin ulceration data in the same manner. The data was descriptively reported and analyzed using chi-square.

As a second indicator of nurse-sensitive patient outcomes, data collection included the total number of falls per 1,000 patient days. Analysis that compared the research and control hospital rates with the national mean utilized chi-square. The data on falls mirrored the data collection times at both the research and control hospitals.

Limitations

The ex post facto design was a limitation in this study since the data collected was limited to the data available and did not include a pre-posttest of the control group .Also this design did not allow for randomization of participants and resulted in a minimal number of minority participants. The development of the survey tool used to collect data occurred prior to the research study; this did not allow time for utilization of a clearly reliable and valid survey. A few nurses wrote on the tool that they were not drowsy or tired at work; therefore, these fatigue countermeasures were not applicable and removed from the results.

The work hour guidelines were not mandatory; therefore, the full potential impact on patient outcomes could not be determined. Other data such as skin ulcerations, patient

safety events, and patient falls were obtained from existing databases. Various individuals within the institution collected this data. Criteria was established and closely followed for patient outcomes such as a fall or skin ulcerations; however, the reporting of patient safety events was dependent upon individual reporting. This may have resulted in some missing data on adverse patient safety events.

The primary researcher and data collectors were currently employed in their respective hospitals. The Hawthorne effect needs consideration, because the workers may have received special attention from the researcher or data collectors (Salkind, 2009). Additionally the distribution and collection of a handed survey may have affected the results due to a concern about their anonymity.

The comparison data collected at the research hospital reflected different times of the year, summer and winter. This could reflect different patient demographics or interest in nurse work hours for multiple reasons. There was not an examination of the reasons for working a specific number of hours, that may be reflective of the season.

Another limitation of the study included the multiple initiatives present within the hospitals to improve patient safety as well as nurse-sensitive patient outcomes. The impact of these initiatives separate from the implemented research interventions became uncontrolled confounding variables.

Due to the limitations and design, this research study was not experimental in nature. Utilization of the same reporting structure for nurse-sensitive patient outcomes, adverse safety events, and utilization of the same survey among all groups was beneficial. Consistency was also found in maintaining the data collection times as a constant. The investigative goal regardless of the method remained the same. The study provided an

examination of nurse work hours following the implementation of work hour guidelines and education and noted its effect on patient outcomes including safety.

CHAPTER IV

FINDINGS AND CONCLUSIONS

Introduction

This chapter reports the collected data of the research study and the analysis of those results. The purpose of this study was to determine if work hour guidelines and education regarding safety risks had an impact on nurses excessive work hours, fatigue management practices, and patient outcomes. The research questions were:

1. What impact did work hour guidelines and fatigue education have on the implementation of fatigue management countermeasures?
2. What impact did work hour guidelines and education have on hours worked?
3. What impact did the implementation of work hour guidelines and education have on adverse safety events?
4. What effect did the implementation of work hour guidelines and education have on nurse-sensitive patient outcomes?

To answer the research questions several methods were utilized. Methods included the examination of pre and post-intervention surveys, as well as a review of data on work hours, patient safety events, and nurse-sensitive patient outcomes. The findings were examined for each survey group. The data analysis presented, compared the groups including matched pairs and confirmed completion of both the pre and post-intervention

survey. Data analysis occurred at the 95% confidence level. Additional data was collected on patient volumes to determine the proportion of safety events.

Findings

Education regarding safety risks was one of the independent variables in the research study. Following the initial survey, nurses in 24-hour patient care units at the research hospital were required to view the computer-based training program on fatigue countermeasures during the months of September and October 2011. The educational program was viewed by 275, or 92%, of the nurses that worked in the participating research study units. The second independent variable, work hour guidelines, were discussed at the research hospital with the nurses by 100% of the managers at the time of the education program. The number of nurses informed by the manager was not measured.

RQ1 – What impact did work hour guidelines and fatigue education have on the implementation of fatigue management countermeasures?

The survey provided to nurses at the research and control hospitals included Likert scale questions that determined their participation in key fatigue management countermeasures. The data collected is presented per group:

Group I - Research hospital nurses, pre-intervention

Group II - Research hospital nurses, post-intervention

Group III - Control hospital nurses, no intervention

Group IV - Research hospital nurses, pre-intervention and post-intervention; matched pairs

The Likert scale consisted of a one to four range, from strongly disagree to strongly agree. Mean responses represented key fatigue management countermeasures and consisted of disagree, measured at a two, or agree, measured at a three, and resulted in a minimum of 2.06 and a maximum of 3.21 (see Table 20). None of the groups strongly agreed, measured at a four, or strongly disagreed, measured at a one, when asked about the presence or absence of fatigue management countermeasures. Of the 11 questions regarding fatigue countermeasures posed to Groups I, II, and III, for a total of 33 questions, only seven questions, or 21.2%, resulted in a mean Likert scale that identified fatigue countermeasures were utilized, score equal or greater than 3.00. According to these results, fatigue countermeasures were not consistently utilized 78.8% of the time. The number of responses to each fatigue countermeasure question, total of all three groups, ranged from 550 to 595 responses. Not all individuals answered each question. The number of responses per group for the fatigue countermeasure questions ranged as follows:

Group I - n = 179 to 209

Group II - n = 181 to 196

Group III - n = 190 to 191

Group IV - n = 80 (subset of Groups I and II)

Data for Groups I, II, and III was analyzed using a one-way ANOVA to test for differences between these groups (see Table 20). Following this, a Tukey post hoc test provided paired comparisons that allowed for the identification of differences between individual pairs. Data analysis of these three groups using one-way ANOVA demonstrated that when a combined total of all fatigue countermeasures was compared

there was a statistically significant difference between all three groups, $F(2, 593) = 7.758$, $p < .01$). The combined total fatigue countermeasures included all 11 elements described above. Comparisons using Tukey post hoc determined there was a statistical difference between Group I and Group II, and Group II and Group III. There was not a statistical difference between Group I and Group III. In summary, following the intervention of education and work hour guidelines there was a statistical difference in the nurses' self-reports of total fatigue countermeasure use. This was not due to the hospital setting; no difference existed between the pre-intervention group at the research hospital and the control hospital that did not participate in the intervention.

In a secondary analysis, to determine the impact of education on the implementation of total fatigue management countermeasures, Group IV was established. Group IV consisted of research hospital nurses that completed the pre-intervention survey, participated in the education and work hour guidelines, and repeated the survey after the intervention. Group IV was determined through a deidentified code on the surveys. Pre-intervention surveys matched per code with post-intervention surveys were analyzed using paired sample *t*-test (see Table 21). Upon analysis of the total of all fatigue countermeasures in the matched pairs, Group IV, there was a statistically significant difference between the pre-implementation group and the post-implementation group, $t(79) = -2.122$, $p < .05$, following education and work hour guidelines.

Continued analysis of the 11 Likert scale fatigue management survey elements allowed for three categorizes to be formulated. The categories included:

Personal behaviors

Work hours

Safety behaviors

Personal Behaviors

The mean and standard deviation of each category for Groups I, II, and III, are present in Table 20. Personal behaviors included such items as the amount of sleep per night, napping, caffeine use, and utilization of a set schedule. The category personal behaviors demonstrated no statistically significant difference when comparing Group I, Group II, and Group III, $F(2,593) = 3.011$, $p > .05$. In a secondary analysis utilizing Group IV, there was a statistically significant difference in the use of personal behavior fatigue countermeasures pre-intervention and post-intervention, in the matched pairs group $t(79) = -2.222$, $p < .05$, (see Table 21).

Work Hours

The second category measured in the survey, work hours, included items such as working a maximum of 50 hours per week, limiting work schedules to three days in a row if working 12-hour shifts or five days in a row if working eight-hour shifts, and taking a 30 minute break. The mean and standard deviations for Groups I, II, and III, are present in Table 20. Analysis utilizing ANOVA determined the total category for work hours was statistically significant $F(2,593) = 8.294$, $p < .01$. When comparing groups using Tukey post hoc, there was a demonstrated difference between Group I and II and Group II & III; however, there was no difference between Group I and III. This demonstrated that the difference was not due to the hospital setting. Secondary analysis utilizing Group IV also demonstrated a statistically significant difference in the use of work hour fatigue countermeasures, $t(79) = -1.996$, $p < .05$ (see Table 21). In the matched

pairs group, there was a significant difference in the use of work hour fatigue countermeasures pre-intervention and post-intervention.

Safety Behaviors

The third category measured in the survey, nurse safety behaviors, included items such as conferring with a co-worker, also known as a wingman, STAR that represented stop, think, act, and review, and QVV which was an acronym for qualify, validate, and verify. All nurses were educated in previous programs to utilize these safety behaviors to prevent errors, especially when encountering difficult situations. The required computer-based education program reminded nurses at the research hospital to utilize these behaviors when fatigued. The mean and standard deviations for Groups I, II, and III, are present in Table 20. Analysis utilizing ANOVA determined the total category for safety behaviors was statistically significant $F(2,593) = 5.401$, $p < .01$. The noted difference was between Group II and III; however, there was no difference between Group I and II, and Group I and III. This demonstrated that the difference identified statistically was most likely due a difference in the hospital settings and not due to the education. As a secondary analysis, Group IV also did not demonstrate a statistically significant difference in using these safety behaviors when results were compared pre-implementation and post-implementation, $t(79) = -1.614$, $p > .05$ (see Table 21). This reaffirmed that the difference in the use of nurse safety countermeasures was most likely not due to the education, but merely due to the difference in the hospital settings.

Individual Fatigue Countermeasure Elements

Upon analysis of each element in the three categories identified above, there was a statistically significant difference found in only four of the 11 elements present on the

survey. Statistical significance was demonstrated across groups in the area of limiting the number of consecutive work days in a row, $F(2,588) = 8.600$, $p < .01$ (see Table 20). Upon further examination, there was a difference between Group I ($M = 2.96$) and Group II ($M = 3.21$), and Group II ($M = 3.21$) and Group III ($M = 2.83$), but no difference between Group I and Group III. This demonstrates there was a statistical change at the research hospital following education and work hour guidelines when nurses reported the number of days worked in a row. The work hour guidelines at the research hospital did include restricting the number of days in a row as measured in the survey. Workdays in a row had not differed statistically when comparing the nurse's response at the research hospital to the nurse's response at the control hospital. The control hospital did not implement work hour guidelines that included restricting the number of days in a row.

Analysis of Group IV, matched pairs at the research hospital, as a secondary analysis confirmed that education and work hour guidelines resulted in a statistical change in the nurses self-report regarding working no greater than three 12-hour shifts in a row or five eight-hour shifts in a row, $t(79) = -3.772$, $p < .01$ (see Table 21). In Group IV, the pre-intervention nurses self-report ($M = 2.90$) was compared with the post-intervention nurses ($M = 3.27$). A self-report was necessary to reflect schedules outside of the hospital setting since some nurses worked a secondary job.

Further analysis of each element within the categories determined that individual elements of safety behavior countermeasures, such as wingman, STAR, and QVV, demonstrated statistical difference (see Table 20).

Wingman – $F(2, 557) = 19.422$, $p < .01$

STAR – $F(2, 559) = 20.258$, $p < .01$

QVV = $F(2, 556) = 18.041$, $p < .01$

Further analysis using Tukey post hoc determined there was a statistically significant difference between Group I and III, but no difference between Group I and II. The statistical difference noted was not a result of the education, merely a difference in the hospital setting.

In a secondary analysis utilizing Group IV, the wingman concept pre-intervention ($M = 2.42$) compared to post-intervention ($M = 2.66$) resulted in statistical significance, $t(70) = -2.162$, $p <.05$, (see Table 21). However, the mean result also identified that despite the statistical increase in utilization, Group IV respondents based on the mean scores reported, did not agree (score 3.00 or greater) that they utilized the wingman concept of conferring with a co-worker when fatigued. The other safety behavior fatigue countermeasures did not show a statistical significance in Group IV pre-intervention and post-intervention; STAR $t(79) = -.948$, $p >$ 05; QVV $t(79) = -.638$, $p > .05$ (see Table 21).

In summary, nurses do not utilize fatigue countermeasures the majority of the time. When fatigue countermeasure education was provided, there was a statistical difference in the use of total fatigue countermeasures. The categories of personal behaviors in the matched pairs, and total work hours of all groups resulted in a statistically significant difference following the interventions. Further analysis determined that the individual element that demonstrated statistical significance included working no more than three 12-hour shifts in a row or five eight-hour shifts in a row. Additional elements reported to be statistically significant, such as the category of safety behaviors, may be the result of the difference in hospital setting versus the implementation of work hour guidelines and education.

RQ2 - What impact did work hour guidelines and education have on hours worked?

Nurses in each group reported on the survey the typical number of hours they worked in a day. This was important since Rogers, et al. (2004) identified that errors were three times higher when nurses worked shifts of 12.5 hours or more. There were 64, or 31.1%, of nurses in Group I, the pre-intervention research group, that reported typical work hours greater than 12.5 hours per day and 53, or 27.4%, of nurses in the post-intervention, Group II. In Group III, 29 nurses, or 15.9%, reported working typical shifts greater than 12.5 hours (see Table 4). There were also nurses that reported working both eight-hour and 12-hour shifts; however, these were not included. One nurse in Group III reported working a 16-hour shift.

Table 4

Nurses Self-report of the Typical Hours Worked Per Day in Past Two Months

Crosstabs	Group I *n* (206)	Group II *n* (193)	Group III *n* (182)	χ^2
Number of Nurses Typical Hours				41.732**
< 12 Hours	2 (2.6%)	20 (10.4%)	59 (32.4%)	
12 to 12.5 Hours	116 (56.3%)	120 (62.2%)	94 (51.7%)	
> 12.5 Hours	64 (31.1%)	53 (27.4%)	29 (15.9%)	

* $p < .05$

** $p < .01$

Analysis of the typical work hours using crosstabs determined that there was a statistical significant difference between Groups I, II, and III, $\chi^2_{(4)} = 41.732$, $p < .01$.

Further analysis with Tukey post hoc resulted in a statistically significant difference between Group I and Group III, and Group II and Group III; however, there was no statistical difference between Group I and Group II. Therefore, work hour guidelines and education did not create a statistical change in the typical hours worked per day.

Group I and Group II - $\chi^2_{(3)} = 1.463$, $p > .05$

Group I and Group III - $\chi^2_{(3)} = 26.907$, $p < .01$

Group II and Group III - $\chi^2_{(3)} = 29.139$, $p < .01$

This suggests that the difference noted in the typical work hours between the research hospital and control hospital was most likely due to the setting. Descriptive confirmation identified more nurses worked eight-hour shifts at the control hospital compared to the research hospital.

Further analysis of the matched pairs, Group IV, at the research hospital did not demonstrate that the work hour guidelines and education resulted in a statistical significance, $\chi^2_{(3)} = 1.086$, $p > .05$ (see Table 5).

Table 5

Typical Hours Worked Per Day in Past Two Months – Group IV

Variable	(Pre-implementation) (*n* = 79)	(Post-implementation) (*n* = 79)	χ^2
Number of Nurses Typical Hours			1.086
< 12 Hours	9 (11.5%)	10 (12.6%)	
12 to 12.5 Hours	47 (59.6%)	46 (58.2%)	
> 12.5 Hours	22 (27.9%)	23 (29.1%)	
8 & 12-Hours	1 (1.0%)		

* $p < .05$

** $p < .01$

Nurse surveys also identified the perceived number of hours worked per week in both the research and control hospitals. Nurses reflected on the prior two months and reported the number of hours worked per week in their primary job. Nurses also reported if they had an additional job and disclosed the hours per week worked in their secondary job. This resulted in three categories of self-reported hours worked:

Primary Hours (primary job)

Secondary Hours (second job)

Total Hours (primary plus secondary if present)

The survey identified a maximum and minimum number of total hours worked for Groups I, II, and III (see Table 22). There was a noted variation in the number of reported hours worked weekly. Within all three groups, nurses reported working as little as two

hours per week and as much as 87 hours per week. Reported work hours for Groups I, II, and III, including primary, secondary, and total hours, were analyzed using a one-way ANOVA. Following this, a Tukey post hoc test provided comparisons that allowed for the identification of differences between individual pairs (see Table 22). There was no statistically significant difference between the primary, $F(2, 556) = 2.005$, $p > .05$, and secondary work hours $F(2,119)= 0.372$, $p > .05$. The total work hours which was a sum of the primary work hours and secondary work hours did show a statistical difference $F(2,556) = 3.061$, $p < .05$. However, in the post hoc analysis there was no difference between Group I ($M = 39.11$) and Group II ($M= 37.87$), and Group I and Group III ($M= 40.63$); there was a difference between Group II and Group III which may have been due to the difference in the hospital setting.

Group IV, the matched pairs group at the research hospital, demonstrated a change in the total minimum hours from 16 hours prior to work hour guidelines and education to 12 hours following work hour guidelines and education. Additionally, at the research hospital, the maximum work hours reported in Group IV changed from 81 hours pre-implementation to 69 hours post-implementation (see Table 23). Statistical analysis of Group IV, pre-intervention ($M = 39.60$) compared to post-intervention ($M = 37.03$), utilized paired sample *t*-test. Total hours worked, the sum of primary and secondary hours, in Group IV demonstrated no statistical significant difference, $t(69) = 1.896$, $p > .05$ prior to work hour guidelines and education and following work hour guidelines and education (see Table 23). Further analysis when comparing primary work hours in the matched pairs pre-implementation ($M = 35.47$) with post-implementation primary work hours ($M = 34.59$), again demonstrated no statistical significant difference, $t(69) = 1.405$,

$p > .05$. In addition, the mean of hours worked at secondary jobs for Group IV, was the same ($M = 12.27$) pre-intervention and post-intervention. Therefore, since the standard error of the difference was zero, a *t*-score was unable to be computed for secondary hours worked.

The established work hour guidelines for patient safety suggested that nurses do not work 50 hours per week or greater. Table 6 represents the number of nurses that self-reported working over 50 combined hours per week at the research hospital, pre-intervention, Group I, post-intervention Group II, and at the control hospital without intervention, Group III. There was a statistically significant difference between all three groups in the nurses perception of the number of hours worked per week, $\chi^2_{(2)} = 90.509$, $p < .01$).

Table 6

Self-Reported Nurse Combined Total Hours Greater than 50 Hours per Week

Crosstabs	Group I (n = 209)	Group II (n = 196)	Group III (n = 191)	χ^2
Number of Nurses that Self-Reported Hours > 50 Per Week	19 (.09%)	9 (.05%)	12 (.06%)	90.509**

* $p < .05$

** $p < .01$

Table 7 represents the number of nurses in Group IV that reported working over 50 combined hours in a week, pre-implementation and post-implementation $\chi^2_{(1)} = 4.103$,

$p < .05$. This demonstrates a statistically significant difference pre-intervention compared to post-intervention.

Table 7

Self-Reported Nurse Combined Total Hours Greater than 50 Hours per Week

Chi-square	Pre-implementation (n = 80)	Post-implementation (n = 80)	χ^2
Number of Nurses that Self-Reported Hours > 50 Per Week	10 (.13%)	3 (.04%)	4.103*

* $p < .05$

** $p < .01$

To further examine the second research question, payroll records through the Human Resource Department at the research and control hospitals identified the number of nurses that worked greater than 100 hours per pay period (see Table 8). A pay period consisted of two weeks of work.

Frequency data for the number of nurses that worked greater than 100 hours per pay period was analyzed using crosstabs. Statistical analysis demonstrated that there was a difference between the pre-intervention, post-intervention, and the control hospital, $\chi^2_{(2)} = 24.863$, $p < .01$. Further analysis using chi-square determined differences between each group presented. Statistical significance was determined between the research and control hospital when comparing the number of nurses that worked greater than 100 hours per pay period; however, this analysis did not consider the control hospital employed a greater number of nurses.

Table 8

Number of Nurses that Worked Greater than 100 Hours per Pay Period

Crosstabs	June/July 2011 Research Hosp (n = 299)	Jan/Feb 2012 Research Hosp (n = 312)	Jan/Feb 2012 Control Hosp (n = 483)	χ^2
Nurses that Worked ≥ 100 Hours per Pay	11(3.7%)	7 (2.2%)	49 (10.1%)	24.863**

* $p < .05$

** $p < .01$

Further analysis identified in Table 9 once again demonstrated that the statistically significant difference may be due to the hospital setting since both the pre-implementation and post-implementation research hospital groups were statistically different from the control hospital. There was no statistical difference between the research hospital pre-implementation and post-implementation, $\chi^2_{(1)} = .294$, $p > .05$.

Table 9

Group Comparison - Number of Nurses that Worked Greater than 100 Hours per Pay Period

CHI-SQUARE	June/July 2011 Research Hosp (n = 299)	Jan/Feb 2012 Research Hosp (n = 312)	Jan/Feb 2012 Control Hosp (n = 483)	χ^2
Nurses that Worked > 100 Hours per Pay	11	7		.294
Nurses that Worked > 100 Hours per Pay	11		49	.001**
Nurses that Worked > 100 Hours per Pay		7	49	.000**

* $p < .05$

** $p < .01$

Data obtained from the Human Resource Department payroll records identified the actual number of hours nurses worked over 100 hours in a two-week period. The means per group were computed as below:

Research Hospital Pre-implementation M = 107.40

Research Hospital Post-implementation M = 106.00

Control Hospital, No implementation M = 110.51

Maximum hours worked by one nurse pre-implementation at the research hospital was 127 hours compared with a maximum of 111 hours worked by one nurse post-implementation. At the control hospital, with no implementation of work hour guidelines and education, one nurse worked a maximum of 177 hours.

A review of actual schedules at the research hospital during the months of June and July 2011 occurred prior to implementation of work hour guidelines and education and following implementation in January and February of 2012. Work hour guidelines discouraged nurses from working greater than three 12-hour shifts in a row. Nurses in all groups exceeded this recommendation (see Table 10).

Table 10

Schedules Reflecting Total of Greater than Three 12-Hour Shifts in a Row

	June/July 2011	Jan/Feb 2012		
Crosstabs	Research Hosp (*n* = 299)	Research Hosp (*n* = 312)	Control Hosp (*n* = 483)	χ^2
Total of greater than Three 12-Hour Shifts in a Row	26 (.09%)	12 (.04%)	16 (.03%)	12.509**

* $p < .05$

** $p < .01$

Group analysis of greater than three 12-hour shifts demonstrated a statistically significant difference with analysis using chi-square, $\chi^2_{(2)} = 12.509$, $p < .01$. Therefore, an analysis per group occurred using the actual number of shifts in a row greater than three. Schedules reflecting four 12-hour shifts was statistically significant, $\chi^2_{(2)} = 7.810$, $p < .05$ (see Table 24). Statistical significance was noted with four 12-hour shifts in a row in the research hospital pre-implementation compared to post-implementation, $\chi^2_{(1)} = 5.194$, $p < .05$ and in the research hospital pre-implementation compared to the control hospital, $\chi^2_{(1)} = 5.457$, $p < .05$ (see Table 25). Schedules reflecting five-12-hour shifts in a row were also analyzed; however, they did not demonstrate any statistical difference,

$\chi^2_{(2)} = 3.272$, $p > .05$ (see Table 26). Additional small numbers were unable to be accurately analyzed, but are reported in Tables 27 through 29.

In summary, self-report, payroll hours and schedules confirmed that nurses exceeded the recommended work hour guidelines. This occurred in all groups including those that received the education and work hour guidelines. However, nurses worked a statistically less number of 12-hour shifts in a row in the research hospital compared prior to and following the implementation of work hour guidelines and education. In some cases, statistical differences in work hours were noted to be due to the hospital setting.

Q3 – What impact did the implementation of work hour guidelines and education have on adverse safety events.

Adverse event data reviewed from reports in the Risk Management Department determined nurse errors that affected patient care. The primary researcher reviewed these adverse events to determine nurse involvement. To confirm nurse involvement, a nurse-sensitive adverse event list was generated and reviewed by a second nurse. Adverse events that were considered nurse-sensitive were reviewed at the research hospital for the period of June and July 2011 prior to the implementation of work hour guidelines and education and then in January and February 2012, post-implementation. Adverse events at the research hospital were examined for the period of January and February 2012 to correspond with the research hospital data collection. Patient volumes were then computed since the control hospital was a larger institution. There was no statistical difference between the three groups using chi-square analysis $\chi^2_{(2)} = 3.613$, $p > .05$ (see Table 11).

Table 11

Number of Nurse-sensitive Adverse Events

	June/July 2011	Jan/Feb 2012		
Crosstabs	Research Hosp	Research Hosp	Control Hosp	χ^2
Adverse Events	80 (.010%)	72 (.009%)	96 (.004%)	3.613

* $p < .05$

** $p < .01$

A risk management nurse at each respective hospital determined the category for each adverse safety event. The categories that were investigated at the research and control hospitals for nurse involvement included adverse outcomes, blood products, delay in treatment, diagnostic labs, medical records, medication event, and system failure, followed by medications (see Table 12).

Table 12

Number of Adverse Safety Events by Category

Category	Research Hospital June/July 2011 (n = 80)	Control Hospital Jan/Feb 2012 (n = 72)	Control Hospital Jan/Feb 2012 (n = 96)	χ^2
Adverse Outcome	2	2	3	
Blood Product	11	4	14	
Delay in Treatment	10	11	7	
Diagnostic Labs	23	14	34	
Medical Records	3	7	2	
Medication Event	16	24	30	
System Failure	15	10	6	
				23.256*

* $p < .05$

** $p < .01$

Although there was not a significant difference across the groups by total events, when event categories were examined, differences were found $\chi^2_{(8)} = 23.256$, $p < .05$. When the categories were further examined there was no difference in medication events $\chi^2_{(2)} = .121$, $p > .05$; however, there was a statistical difference in the diagnostic labs, $\chi^2_{(2)} = 8.479$, $p < .05$.

Additionally, each safety event was assigned a rank ordered numerical level one through five by the risk management nurse according to severity. These severity levels included no harm, minimal harm, treatment required, higher level of care required, and

death. The severity levels were then summed into 1evel one, no harm and levels two through four, harm. No level fives were present (see Table 13).

Table 13

Adverse Safety Events – No Harm vs. Harm

Category	Research Hospital June/July 2011 (n = 80)	Research Hospital Jan/Feb 2012 (n = 72)	Control Hospital Jan/Feb 2012 (n = 96)	χ^2
No Harm	63	61	80	
Harm	17	11	16	
				1.050

* $p < .05$

** $p < .01$

Chi square was utilized to analyze safety events by harm and no harm. An analysis occurred between the research hospital pre-implementation, June/July 2011, and post-implementation, January/February data, as well as the control hospital. There was not a statistical difference noted, $\chi^2_{(3)} = 1.050$; $p > .05$ when comparing harm versus no harm.

Since the control hospital had a larger volume of patients, as a secondary analysis, *z*-scores were calculated. Analysis of the total number of adverse events using a *z*-test proportioned for patient volumes resulted in no difference between the research hospital pre-implementation, before work hour guidelines and education, and post-implementation after work hour guidelines and education ($z = 0.123$, $p > .05$). There was a statistically significant difference between the research hospital pre-implementation and the control hospital ($z = 5.032$, $p < .05$) and the research hospital post-implementation and the

control hospital ($z = 4.776$, $p < .05$). The statistical significance was most likely due to the setting despite the patient volume correction.

In a secondary analysis, again adjusting for patient volumes, adverse events causing no harm were analyzed using z scores. There was no significant difference at the research hospital before implementation of work hour guidelines and education and after work hours guidelines and education ($z = 0$, $p > .05$). There was a statistical difference noted between the research hospital pre-implementation and the control hospital ($z = 4.671$, $p < .01$) and between the research hospital post-implementation and the control hospital ($z = 4.671$, $p < .01$). This may be due to the difference in the setting between the research hospital and the control hospital.

Adverse events resulting in harm were also analyzed using z scores. There was no significant difference between the research hospital pre-implementation compared to post-implementation ($z = 1.545$, $p > .05$). When the research hospitals pre-implementation group was compared with the control hospital, a statistically significant difference was noted ($z = 2.764$, $p < .05$); however, when the research hospital post-implementation group was compared with the control hospital there was not a statistical difference ($z = 0.116$, $p > .05$). Despite the correction for patient volumes, the statistical difference again may be due to the setting.

In summary, there was not a significant difference between the total adverse events pre-implementation, post-implementation, and at the control hospital. Events by category were statistically significant and upon further analysis demonstrated that the difference occurred with diagnostic laboratory adverse events. Upon evaluation of harm and no harm, there was not a statistically significant difference in comparing all three

groups. Even with the analysis of total adverse events, events causing no harm, events causing harm, and adjustment for patient volumes, the statistical difference that resulted was most likely due to the setting and not due to the implementation of work hour guidelines and education.

RQ4 – What effect did the implementation of work hour guidelines and education have on nurse-sensitive patient outcomes?

Nurse sensitive patient outcome categories evaluated in this research study included skin ulcerations and patient falls. Each of these were measured per thousand patient days according to the criteria set by the National Database of Nursing Quality Indicators (NDNQI) and compared against the national mean per category. The total number of hospital acquired skin ulcers and patient falls pre-implementation and post-implementation decreased; however, the numbers were very small (see Table 14 and 15).

Table 14

Total Number of Hospital-Acquired Skin Ulcerations per Thousand Patient Days

	Research Hospital		Control Hospital
	June/July 2011	Jan/Feb 2012	Jan/Feb 2012
Hospital-Acquired Skin Ulcerations per 1,000 Patient Days	.78	0	0.61
National Mean Hospital Acquired Skin Ulcerations per 1,000 Patient Days	3.13	3.04	3.04

Table 15

Total Number of Patient Falls per Thousand Patient Days

	Research Hospital		Control Hospital
	June/July 2011	Jan/Feb 2012	Jan/Feb 2012
Patient Falls per 1,000 Patient Days	3.12	1.93	3.39
National Mean Hospital Total Patient Falls per 1,000 Patient Days	3.48	4.11	4.11

National data rates from the NDNQI for non-teaching hospitals was determined in order to provide a comparison for hospital acquired skin ulcerations and total patient falls. Hand calculation using the chi-square formula compared observed versus expected results. The calculations below for skin ulcerations were not statistically significant.

June/July $\chi^2 = \Sigma \frac{(0.78 - 3.13)^2}{3.13}$ $\chi^2_{(1)} = 1.76, p > .05$

Jan/Feb $\chi^2 = \Sigma \frac{(0.00 - 3.04)^2}{3.04}$ $\chi^2_{(1)} = 3.04. p > .05$

Jan/Feb $\chi^2 = \Sigma \frac{(0.61 - 3.04)^2}{3.04}$ $\chi^2_{(1)} = 1.94, p > .05$

The following hand calculation using the Chi Square formula compared what was observed versus what was expected in relation to total patient falls. None of these values was statistically significant at the .05 level.

June/July $\chi^2 = \Sigma \frac{(3.12 - 3.48)^2}{3.48}$ $\chi^2_{(1)} = .04, p > .05$

Jan/Feb $\chi^2 = \Sigma \frac{(1.93 - 4.11)^2}{4.11}$ $\chi^2_{(1)} = 1.16, p > .05$

Jan/Feb $\chi^2 = \Sigma \frac{(3.39 - 4.11)^2}{4.11}$ $\chi^2_{(1)} = .13, p > .05$

In summary, the effect of work hour guidelines and education on safety-sensitive indicators did not result in statistical significance. Obtained results may also be related to the small number of skin ulcerations and falls.

Conclusions

The participating nurses in this study demonstrated that fatigue countermeasures were not routinely used to combat fatigue. The utilization of fatigue countermeasures to promote patient safety was not inherent. In an analysis of total fatigue countermeasures, there was a statistically significant difference between all three groups, pre-implementation, post-implementation and no implementation. This relationship was not due to the differences in the setting between the research and control hospitals, rather the difference followed the implementation of work hour guidelines and fatigue countermeasure education. Further analysis of the matched pairs at the research hospital resulted in a statistically significant difference pre-implementation and post-implementation following work hour guidelines and fatigue education. This demonstrated that additional fatigue education programs for nurses might be advantageous to increase the use of fatigue countermeasures.

Further analysis of the countermeasures demonstrated that the category of work hours was statistically significant between all three groups, pre-implementation, post-implementation, and no implementation. This was not due to the difference in the setting between the research and control hospitals. Again, this noted difference occurred following work hour guidelines and education. Secondary analysis using matched pairs also demonstrated a significant difference in the use of work hour fatigue countermeasures pre-implementation and post-implementation.

Individual elements also confirmed a significant reduction in working more than three 12-hour shifts in a row or five 8-hour shifts in a row. The encouragement provided by work hour guidelines and education to utilize work hour countermeasures may be a reflection of these results.

Additional categories and elements such as personal behaviors and the use of a wingman to check their work when fatigued was also noted to be statistically significant following the implementation of work hour guidelines and education. According to this research study there was a significant change in the use of fatigue countermeasures following work hour guidelines and education. The theme presented here is important since the implementation of hospital fatigue education and countermeasures programs for nurses had been rarely reported in the research literature (Scott, et al., 2010b).

One countermeasure of great concern that did not result in a statistical change was the lack of 30-minute breaks during the workday. This is of concern since labor regulations require employers to provide a break to employees. Nurses in all three groups stated they did not routinely take a break of 30 minutes during the workday. Nurses and nursing leaders clearly need to determine how breaks can be incorporated into the nurses work day.

Further analysis of actual work hours, demonstrated excessive hours were worked by some nurses. One nurse declared working 87 hours in a week. Interestingly, 47, or 22.7% of the nurses at the research hospital reported working a second job, and 41, or 21.8% of nurses at the control hospital reported working a second job. Payroll records of nurses that worked greater than 100 hours per pay period also confirmed the presence of excessive work hours. One nurse in this group worked 177 hours in two weeks. To

promote patient safety, work hour guidelines in the literature supported working less than 60 hours per week; the research hospital guidelines supported working less than 50 hours per week. Nurses in this study exceeded these limits.

Other research studies correlated work hours greater than 12.5 hours per day with a greater amount of medical errors. In this study there were 64, or 30.8%, of nurses in the pre-intervention research group, that reported working greater than 12.5 hours per day and 29, or 15.3%, of nurses in the control hospital. Reported work hours per day beyond 12.5 was significantly different between the research and control hospitals; however the control hospital nurses, reported working more eight-hour shifts than the research hospital.

Self-reported total hours worked included primary work hours and secondary work hours. Importantly, this analysis included several nurses that worked a second job. Analysis of all three groups resulted in a statistical difference; however, the difference was due to the hospital setting and not due to work hour guidelines and education. This was confirmed by the paired-samples *t*-test that again did not demonstrate statistical significance in total hours worked. Interestingly, the secondary work hours in the paired group did not change at all. Work hour guidelines presented to the nurses at the research hospital also recommended work hours of no greater than three 12-hour shifts in a row or five eight-hour shifts in a row. One nurse in the pre-implementation group at the research hospital worked six 12-hour shifts in a row, and one nurse worked seven 12-hour shifts in a row. All groups violated the recommendation of no greater than three 12-hour shifts in a row; however, there was a statistical change in the research hospital pre-implementation compared with post-implementation following work hour guidelines and education.

This study also looked at nurse-sensitive adverse safety events at both the research and control hospitals. When analyzed, there was no statistical difference in total events; however, there was a statistically significant difference based on the category of the event. Adverse safety events were also examined to determine if there was harm to the patient. There was not a difference between harm and no harm at the research hospital and other differences noted were due to the difference in the setting between the research and control hospitals. Although this study did not show that adverse events statistically increased due to excessive work hours, other studies reported this finding and therefore, nurses and their employers need to continue to curb excessive work hours.

The data presented on patient falls and hospital acquired skin ulcerations was evaluated on an individual basis since harm may result from these outcomes as well. Each avoidance of a hospital acquired skin ulcer or patient fall decreases the risk to the patient; however, calculations using chi square did not identify a statistically significant difference compared to the national average according to national data as collected by the NDNQI.

Implications and Recommendations

No single action, by itself, can affirm the delivery of safe patient care. To substantially reduce errors and increase patient safety multiple components and processes are needed (Page, 2004). Recommended components to promote patient safety included the management of nurse work hours and the utilization of fatigue countermeasures. Nurses continually face the challenge of balancing the safety needs of patient’s along with personal, family, and financial needs.

The results achieved in this study with voluntary work hour guidelines and education identified the importance of the nurse manager in scheduling nurses. Focused attention by the nurse manager promoted adherence to work schedules of no greater than three twelve-hour shifts in a row. Maintaining the recommendations by the Institute of Medicine, the American Nurses Association, and the American Organization of Nurse Executives is not easy since the nurse manager continually faces the challenge of balancing patient volumes, acuity, and financial needs of the institution.

Despite several recommendations, this study demonstrated that some nurses continued to exceed the recommended work hours. This opens the door to additional safety risks. Several other safety-sensitive professions are guided by federal regulations to curtail excessive work hours. Nurses must take action to self-regulate their work hours to avoid the potential of regulation. Administrators overseeing employees in safety-sensitive positions should recognize this inherent risk and promote enforceable work hour guidelines prior to regulation. Additionally, education provided to employees in other safety-sensitive industries regarding work hours and safety needs expansion to the health-care environment. This study confirms the need for education since it demonstrated success in the use of an educational program for nurses to improve the use of fatigue countermeasures.

This research project demonstrated the complexity that occurred when work hours and fatigue countermeasures were compared with patient outcomes. Limitations of the study included the implementation of volunteer work hour guidelines, a survey developed by the principle investigator, the difference in the research and control hospital settings, a

hand survey soliciting information that may be considered sensitive, and the lack of awareness of the number of nurses who were informed about the work hour guidelines. The utilization of the last three numbers of the nurses social security number as a coding system was also a limitation since this may have caused the less than desired matched pairs. All of these measures may have influenced the findings of this study. Studies eliminating these limitations would strengthen the research surrounding this topic.

Further research is recommended to explore this topic among a greater number of nurses including nurses in other healthcare settings. Additional research is needed to examine all health-care employees in safety-sensitive positions. Research that is not ex post facto would also be beneficial because this would allow greater opportunity to develop a valid and reliable survey tool for the measurement of fatigue countermeasures. Research utilizing mandatory work hour guidelines needs to occur to determine the effect of total compliance of work hour guidelines and education on patient outcomes. Continued examination of nurse work hours and fatigue countermeasures to avert an adverse safety outcome is critical because harm from even one safety event can be devastating for both the patient and the nurse.

REFERENCES

Accreditation Council for Graduate Medical Education (2002). *Report of the ACGME work group on resident duty hours.* Retrieved from http://www.acgme.org/acWebsitedutyhours/dh_wkgroup611.pdf

Accreditation Council for Graduate Medical Education (2011). *Common program requirements.* Retrieved from http://www.acgme-2010standards.org/pdf/Common_Program_Requirements_07012011.pdf

Adams, C. F. (1879). *Railroad accidents.* Retrieved from http://catskillarchive.com/rrextra/wkbktoc.html

Agency for Healthcare Research and Quality (2010). *National healthcare disparities report, Chapter 3 patient safety*. Retrieved from http://www.ahrq.gov/qual/nhdr10/Chap3.htm

Akerstedt, T. (1985). Shifted sleep hours. *Annals of Clinical Research, 17*(5), 273-279.

Akerstedt, T., Fredlund, P., Gillberg, M., & Jansson, B. (2002). Work load and work hours in relation to disturbed sleep and fatigue in a large representative sample. *Journal of Psychosomatic Research, 53*, 585-588.

American Nurses Association (2004). *The National Database.* Retrieved from http://www.nursingworld.org/MainMenuCategories/ThePracticeofProfessionalNursing/PatientSafetyQuality/Research-Measurement/The-National-Database.aspx

American Nurses Association. (2006a). *Assuring patient safety: The employers' role in promoting health nursing work hours for Registered Nurses in all roles and settings.* Retrieved from http://nursingworld.org/MainMenuCategories/ThePracticeofProfessionalNursing/workforce/NurseShortageStaffing/NurseFatigue/EmployersRole.aspx

American Nurses Association. (2006b).*Assuring patient safety: Registered nurses responsibility in all roles and settings to guard against working when fatigued.* Retrieved from http://www.nursingworld.org/MainMenuCategories/EthicsStandards/Ethics-Position-Statements/Copy%20of%20AssuringPatientSafety_1.aspx

American Nurses Association. (2010). *Mandatory overtime.* Retrieved from http://nursing world.org/MainMenuCategories/ANA Political Power/State/StateLegislativeAgenda/MandatoryOvertime.aspx

American Organization of Nurse Executives (2003). *Policy statement on mandatory overtime.* Retrieved from http://www.aone.org/resources/leadership%20tools/PDFs/ps_mandatory_ot.pdf

Anderson, E. E., & Buchholz, R. A. (1988). Economic instability and occupational injuries: The impact of overtime hours and turnover rates. *Labor Studies Journal, 13*(4), 33-49.

Arnoult, S. (2009). The problem that won't go away. *Air Transportation World, 46*(8), 26-31.

Asch, D. A., & Parker, R. M. (1988). Sounding board: The Libby Zion case. *The New England Journal of Medicine, 318*(12), 771-775.

Balas, M. C., Scott, L. D., & Rogers, A. E. (2004). The prevalence and nature of errors and near errors reported by hospital staff nurses. *Applied Nursing Research, 17*(4), 224-230.

Balkin, T. J., Bliese, P. D., Belenky, G., Sing, H., Thorne, D. R., Redmond, D. P. …Wesensten, N. J. (2004). Comparative utility of instruments for monitoring sleepiness-related performance decrements in the operational environment. *Journal of Sleep Research, 13*, 219-227. doi:10.1111/j.1365-2869.2004.00407

Barger, L. K., Ayas, N. T., Cade, B. E., Cronin, J. W., Rosner, B., Speizer, F. E., & Czeisler, C. (2006). Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. *PLOS Medicine, 3*(12), 2440-2448.

Barger, L. K., Cade, B. E., Ayas, N. T., Cronin, J. W., Rosner, B., Speizer, F. E. & Czeisler, C. A. (2005). Extended work shift and the risk of motor vehicle crashes among interns. *The New England Journal of Medicine, 352*, 125-134. Doi:10:1056/NEJMoa0414401

Belenky, G., Wesesten, J. J., Thorne, D. R., Thomas, m. L., Sing, H., Redmond, D. P., Russo, M. B., & Balkin, T. J. (2003) Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: A sleep dose-response study. *Journal of Sleep Research 12*, 1-12.

Braver E. R., Preusser C. W., Preusser, H. M., Baum H. M., Beilock R., & Ulmer R. (1992). Long hours and fatigue: A survey of tractor-trailer drivers. *Journal of Public Health Policy 13*(3), 341–366.

Caldwell, J. A., Mallis, M. M., Caldwell, L., Paul, M. A., Miller, J. C., & Neri, D. E. (2009). Fatigue countermeasures in aviation. *Aviation, Space, and Environmental Medicine, 80*(1), 29-59.

Caruso, C. C., & Hitchock, E. M. (2010). Strategies for nurses to prevent sleep-related injuries and errors. *Rehabilitation Nursing, 35*(5), 192-197.

Castro, A. B., Fujishiro, K., Rue, T., Tagalong, E. A., Samaco-Pazuiz, L. P. G., & Gee, G. C. (2010). Associations between work schedule characteristics and occupational injury and illness. *International Nursing Review, 57*, 188-194.

Center for transforming healthcare aims to reduce wrong site surgery. (2011, June 29). *Joint Commission Center for Transforming Healthcare.* Retrieved from http://www.centerfortransforminghealthcare.org/news/detail.aspx?ArticleId=293996

Christiansen, J. (1992). The heart of darkness. *Journal of General Internal Medicine, 7*(4), 424-431.

Coplen, M. & Sussman, D. (2000). *Fatigue and alertness in the United States railroad industry Part II: Fatigue research in the office of research and development at the Federal Railroad Administration.* Retrieved from http://www.volpe.dot.gov/hf/docs/pap2fi-2.html

Curtin, L. (2003). An integrated analysis of nurse staffing and related variables: Effects on patient outcomes. *Online Journal of Issues in Nursing, 8*(3). Retrieved from www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANA Periodicals/OJIN/KeynotesofNote/StaffingandVariablesAnalysis.aspx

DataStar, StarStat: Significant testing calculator. (n. d.)Retrieved from http://www.surveystar.com/our_services/ztest.htm

Dawson, D., & Reid, K. (1997). Fatigue, alcohol, and performance impairment. *Nature 388*(6639), 235.

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 doi:10.1016/j.adnc.2006.02.001

Department of Labor, State of Illinois, (2003). 820 ILCS 140/One day rest in seven act. Retrieved from http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2407/& Chap/Act=820ILCS140/&ChapterID

Department of Transportation, Federal Aviation Administration. (2010). Flightcrew member duty and rest requirement. Federal Register Vol 75 No. 177 September 14, 2010/Proposed Rules. 14 CFR parts 117-121

Dorrian, J., Tolley, C., Lamond, N., Heuvel, C., Pincombe, J., Rogers, A. E., & Dawson, D. (2008). Sleep and errors in a group of Australian hospital nurses at work and during the commute. *Applied Ergonomics 39*(5) 605-613.

Edles, G. (2004). *Motor carrier act*. Retrieved from http://www.highbeam.com/doc/1G2-3407400193.html

Emori, T. G., Culver, D. H., Horan, T. C., Jarvis, W. R., White, J. W., Olson, D. R. … Gaynes, R. P. (1991). National nosocomial infections surveillance system (NNIS): Description of surveillance methods. *American Journal of Infection Control, 19*(1), 19-35.

Exxon Valdez Oil Spill Trustee Council. (1990). *Details about the accident.* Retrieved from http://www.evostc.state.ak.us/facts/details.cfm

Federal Aviation Administration. (n.d.). *Fatigue Links.* Retrieved from https://hfskyway.faa.gov/HFSkyway/FatigueLinks.aspx?AspxAutoDetectCookieSupport=1#FATIGUEEDUCATION

Federal Aviation Administration. (2008). *Human factors guide for aviation maintenance and inspection.* Retrieved from http://www.hf.faa.gov/hfguide/03/03_concepts.html

Federal Aviation Administration. (2010a). FAA proposes sweeping new rule to fight pilot fatigue. Retrieved from http://www.faa.gov/news/press_releases/news_story.cfm?newsId=11839

Federal Aviation Administration. (2010b). *Fact sheet – pilot flight time, rest, and fatigue.* Retrieved from http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=6762

Federal Aviation Administration. (2010c). *Fatigue Risk Management Plans (FRMP) for Part 121 Air Carriers – Part Two,* Retrieved from http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2010/InFO10017.pdf

Fields, W. L. & Loveridge, C. (1988). Critical thinking and fatigue: How do nurses on 8- & 12-hour shifts compare? *Nursing Economics*, *6*(4), 189-191.

Frey, B., Kehrer, B., Losa, M., Braun, H., Berweger, l., Micallef, J., & Ebenberger, M. (2000). Comprehensive critical incident monitoring in a neonatal-pediatric intensive care unit: Experience with the system approach. *Intensive Care Medicine, 26*, 69-74.

Friedman, R. C., Bigger, J. T., & Kornfeld, D. S. (1971). The intern and sleep loss. *The New England Journal of Medicine, 285*(4), 201-203.

Fuller, T. P., & Bain, E. (2010). Shift workers five sleep short shift. *American Journal of Nursing, 110*(2), 28-30.

Gangwisch. J. E., (2009) All work and no play makes Jack lose sleep. *Sleep, 32*(6), 717-718.

Gangwisch, J. E., Malaspina, D., Babiss, L. A., Opler, M. G., Posner, K….Ginsberg, H. N. (2010). Short sleep duration as a risk factor for hypercholesterolemia: Analyses of the National Longitudinal Study of Adolescent Health, *Sleep, 33*(7), 956-961.

GPO Access (2010). *Code of Federal Regulations.* §15.701. Retrieved from http://frwebgate2.access.gpo.gov/cgi-bin/PDFgate.cgi?WAISdocID=ysdjWS/1/2/0&WAISaction=retrieve

GPO Access. (2011). *Code of federal regulations* ξ395.5. Retrieved from http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=57ff800b198bf67ccd3bd9bcb6b62388&rgn=div5&view=text&node=49:5.1.1.2.38&idno=49#49:5.1.1.2.38.0.13.4

Gunther, D. (2008). Operational benefits of a fatigue risk management system (FRMS) *Presented at the Federal Aviation Administration Management Symposium: Partnerships for Solutions.* Retrieved from http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs200/media/aviation_fatigue_symposium/GuntherAppComplete.pdf

Hänecke, K., Tiedemann, S., Nachreiner, F., & Grzech-Sukalo, H. (1998). Accident risk as a function of hour at work and time of day as determined from accident data and exposure models for the German working population. *Scandinavian Journal of Work, Environment & Health, 24*(3) 43-48.

Hixson, L., Hepler, B. R., & Kim, M. O. (2011) *The white population: 2010.* United States Census Bureau, United States Department of Commerce. Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-05.pdf

Hughes, R. G. (Ed.). (2008). Patient safety and quality: An evidence-based handbook for nurses. *Agency for Healthcare Research and Quality*. Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK2651/

Hughes, R. G., & Rogers, A. E. (2004). Are you tired?: Sleep deprivation compromises nurses' health – and jeopardizes patients. *American Journal of Nursing, 104*(3), 36-38.

Hursh, S. R., Redmond, D. P., Johnson, M. L., Thorne, D. R., Belenky, G., Balkin, T. J….Eddy, D. R. (2004). Fatigue models for applied research in warfighting. *Aviation, Space, and Environmental Medicine, 75*(1), A44-A53.

Jha, A. K., Duncan, B. W., & Bates, D. W. (2001). Fatigue, sleepiness, and medical error, in making health care safer. *Agency for Healthcare Research & Quality*, pp. 519-532. Retrieved from http://archive.ahrq.gov/clinic/ptsafety/chap46a.htm

Johnson, A. L., Brown, K., & Weaver, M. T. (2010). Sleep deprivation and psychomotor performance among night-shift nurses. *American Association of Occupational Health Nurses, 58*(4), 447-454. doi: 10.3928/08910162-20100316-02

Kivimäki, M., Batty, G. D., Hamer, M., Ferrie, J. E., Vahtera, J., Virtanen, M.,…Shipley, M. J. (2011). Using additional information on working hours to predict coronary heart disease. *Annals of Internal Medicine, 154*, 457-463.

Knauth, P. (1993). The design of shift systems. *Ergonomics, 36*(1), 15-28.

Knauth, P. (1996). Designing better shift systems. *Applied Ergonomics 27*(1), 39-44.

Knauth, P. (2007). Extended work periods. *Industrial Health, 45*, 125-136.

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000). *To err is human: Building a safer health system.* Retrieved from http://books.nap.edu/openbook.php?isbn=0309068371

Kuppermann, M. Lubeck, D. P., Mazonson, P. D., Patrick, D. L., Stewart, A. L., Buesching, D. P., & Fifer, S. K. (1995). Sleep problems and their correlates in a working population. *Journal of General Internal Medicine, 10*, 25-32.

Landrigan, C. P., Barger, L. K., Cade B. E., Ayas, N. T., & Czeisler, C. A. (2006). Interns' compliance with accreditation council for graduate medical education work-hour limits. *Journal of the American Medical Association, 296*(9), 1063-1070.

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

Leape, L. L., & Abookire, S. (2005). *WHO draft guidelines for adverse event reporting and learning systems.* Retrieved from http://www.who.int/patientsafety/events/05/Reporting_Guidelines.pdf

Leape, L. L., Bates, D. W., Cullen, D. J., Cooper, J., Demonaco, H. J., Gallivan, T., … Vliet, M. V. (1995). Systems analysis of adverse drug events. *Journal of the American Medical Association, 274*(1), 35-43.

Leape, L. L., & Berwick, D. M. (2005). Five years after to err is human. *Journal of the American Medical Association, 293*(19), 2384-2390.

Leedy, P. D., & Ormrod, J. E. (2010). *Practical research: Planning and design.* (9th ed). Upper Saddle River, NJ: Merrill Prentice Hall.

Lipscomb, J. A., Trinkoff, A. M., Geiger-Brown, J., & Brady, B. (2002). Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scandinavian Journal of Work Environment & Health, 28*(6), 394-401.

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

Lombardi, D. A., Folkard, S., Willets, J. L., & Smith, G. S. (2010). Daily sleep, weekly working hours, and risk of work-related injury: US national health interview survey (2004-2008). *Chronobiology International, 27*(5), 1013-1030. doi:10.3109/07420528.2010.489466

Louwe, H., & Kramer, A. (2001). Case studies of nursing care facility staffing issues and quality of care. *Report to Congress: Appropriateness of Minimum Nurse Staffing Ratios in Nursing Homes—Phase II Final Report.* [Online]. Retrieved from www.cms.gov/medicaid/reports/rp1201home.asp

May, R., & Fortner, K. (2010). *HealthGrades Seventh Annual Patient Safety in American Hospitals.* Retrieved from http://www.healthgrades.com/business/img/PatientSafetyInAmericanHospitalsStudy2010.pdf

McCarthy, D. & Klein, S. (2011). Sentara healthcare: Making patient safety and enduring organizational value. *The Commonwealth Fund*, *1476*(8), 1-18. Retrieved from http://www.commonwealthfund.org/~/media/Files/Publications/Case%20Study/2011/Mar/1476_McCarthy_Sentara_case_study_FINAL_March.pdf

Minority Nurse (2010), *Nursing Statistic.* Retrieved from http://www.minoritynurse.com/minority-nursing-statistics

Mitler, M. M., Carskadon, M. A., Czeisler, C. A., Dement, W. C., Dinges, D. F., & Graeber, R. C. (1998). Catastrophes, sleep, and public policy: Consensus report, *Sleep 11*(1), 100-109.

Mitler, M. M., Miller, J. C., Lipsitz, J. J., Walsh, J. K., & Wylie, C. D. (1997). The sleep of long-haul truck drivers. *The New England Journal of Medicine, 337*(11), 755-761.

National Data Base of Nursing Quality Indicators, guidelines for data collection on the American Nurses Association national quality forum endorsed measures: Nurse care hours per patient day, skill mix, falls, falls with injury (2010). Retrieved from http://www.odh.ohio.gov/ASSETS/70E9E4A092A94B70AEB05A145629E9E3/July%2013%20handouts.pdf

National Transportation Safety Board. (2009). *Loss of control on approach, Colgan Air, Inc.* Retrieved from http://www.ntsb.gov/publict/2010/AAR1001.htm

Needleman, J., Kurtzman, E. T., & Kizer, K. W. (2007). Performance measurement of nursing care: State of the science and the current consensus'. *Medical Care Research and Review 64*(2), 10S-43S

New York Codes, Rules and Regulations, Title 10 § 405.4 (1998).

New York State, Department of Health. (1998). Retrieved from http://www.health.ny.gov/press/releases/1998/vincents.htm

Nishiyama, K., & Johnson, J. V. (1997). Karoshi-Death from overwork: Occupational health consequences of the Japanese production management, *Job Stress Network*. Retrieved from http://www.workhealth.org/whatsnew/lpkarosh.html

O'Brien-Pallas, L., Shamian, J., Thomson, D., Alksnis, C., Koehoorn, M., Kerr, M., & Bruce, S. (2004). Work-related disability in Canadian nurses. *Journal of Nursing Scholarship, 36*(4), 352-357.

Office of Graduate Medical Education, Duke University Hospital. (2010). *Prevention, identification, and management of fatigue in graduate medical education.* Retrieved from http://www.gme.duke.edu/newsletters/2010December/Fatigue_11-16-2010.pdf

Olds, D. M. & Clarke, S. P. (2010) The effect of work hours on adverse events and errors in health care. *Journal of Safety Research 41*, 153-162.

Oncology Nurses Association. (2004). *Nurse sensitive patient outcomes.* Retrieved from http://www.ons.org/Research/NursingSensitive/

Owens, J., Avidan, A., Baldwin, D., Chesson, A., Cook, S., Harding, S….Zee, P. (2003). Sleep, alertness, and fatigue education in residency (SAFER) program: Background information and references. Retrieved from http://www.umm.edu/imres/Policies/Sleep-SAFERIntroRefList.pdf

Page, A. (Ed.). (2004), *Keeping patients safe: Transforming the work environment of nurses.* [Free Executive Summary]. Retrieved from http://www.nap.edu/catalog/10851.html

Park, J., Kim, Y., Chung, H., & Hisanaga, N. (2001). Long working hours and subjective fatigue symptoms. *Industrial Health, 39*, 250-254

Poetry Foundation. (2009). *An essay on criticism*. Retrieved from http://www.poetryfoundation.org/learning/poetics-essay/237826?page=8

Printup, M. B. (2000, September 10). Affects of fatigue on performance and safety. Retrieved from http://www.avweb.com/news/aeromed/181871-1.html

Public Laws of the United States of America. *Federal Hours of Service Act 5927, 34 Stat. 1415 (1907).*

Public Laws, *49 USC Chapter 211 - Hours of Service.* (2008). Retrieved from http://bletdivision231.com/BLET/The_New_H.O.S_files/49USCChapter211_1.pdf

Reason, J. (1990). *Human error*. New York, NY: Cambridge University Press

Reason, J. (2000) Human error: Models and management. *British Medical Journal, 320*(7237), 768-770.

Reed, K., & May, R. (2011). *HealthGrades Patient Safety in American Hospitals Study.* Retrieved from http://www.healthgrades.com/business/img/ HealthGradesAmericas50BestHospitalsReport2011.pdf

Rogers, A. E. (2004). *Work hour regulation in safety-sensitive industries.* In *Keeping patients safe: Transforming the work environment of nurses.* [Free Executive Summary]. p.p. 384-431. Retrieved from http://www.nap.edu/catalog/10851.html

Rogers, A., Holmes, S., & Spencer, M. (2001). The effect of shiftwork on driving to and from work. *Journal of Human Ergology, 30*, 131-136.

Rogers, A. E., Hwang, W., & Scott, L. D. (2004). The effects of work breaks on staff nurse performance. *Journal of Nursing Administration*, *34*(11), *512-519.*

Rogers, A. E., Hwang, W., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004). The working hours of hospital staff nurses and patient safety: Both errors and near errors are more likely to occur when hospital staff nurses work twelve or more hours at a stretch. *Health Affairs, 23*(4), 202-212.

Rosa, R. R. (1988). Long workdays versus rest days: Assessing fatigue and alertness with a portable performance battery. *Human Factors, 30*(3), 305-317.

Rosa, R. R. (1991). Performance, alertness, and sleep after 3.5 years of 12 h shifts: A follow-up study. *Work & Stress, 5*(2), 107-116.

Rosekind, M. R., Gander, P. H., Gregory, K. B., Smith, R. M., Miller, D., Oyung, R. …Johnson, J. M. (1997). Managing fatigue in operational settings. *Hospital Topics, 75*(3), 23-30.

Russell, B., Ehrenkranz, N. J., Hyams, P. J., & Gribble, C. A. (1983). An outbreak of staphylococcus aureus surgical wound infection associated with excess overtime employment of operating room personnel. *American Journal of Infection Control, 11*(2), 63-67.

Salkind, N. J. (2009). *Exploring research.* (7th ed). Upper Saddle River, NJ: Pearson.

Scalense, R. (Ed.). (2006). *JCAHO announces potential 2008 national patient safety goals.* Retrieved from http://www.healthleadersmedia.com/content/HOM-85527/JCAHO-announces-potential-2008-National-Patient-Safety-Goals.html

Scott, L. D., Hofmeister, N. Rogness, N., & Rogers A. E. (2010a). An interventional approach for patient and nurse safety. *Nursing Research, 59*(4), 250-258.

Scott, L. D., Hofmeister, N. Rogness, N., & Rogers A. E. (2010b). Implementing a fatigue countermeasures program for nurses. *The Journal of Nursing Administration, 40*(5), 233-240.

Scott, L., Hwang, W., & Rogers, A. E. (2006). The impact of multiple care giving roles on fatigue, stress, and work performance among hospital staff nurses. *The Journal of Nursing Administration, 36*(2), 86-95.

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

Scott, L. D., Rogers, A. E., Hwang, W., & Zhang, Y. (2006). Effects of critical care nurses' hours on vigilance and patients. [Electronic version]. *American Journal of Critical Care, 15,* 30-37. Retrieved from http://url.www.cinahl.com/cgi-bin/refsvc?jid=607&aacn2009096375

Sitzmann T., Kraiger, K., Stewart, D., & Wisher, R. (2006). The comparative effectiveness of web-based and classroom instruction: A meta-analysis. *Personnel Psychology, 59*, 623-664. Retrieved from http://www.online.colostate.edu/global/docs/WebBasedInstruction-Sitzmann2006.pdf

Smith, L., Folkard, S., Tucker, P., & Macdonald, I. (1998). Work shift duration: A review comparing eight hour and 12 hour shift systems. *Occupational Environmental Medicine,* 55, 217-229.

Smith-Coggins, R., Howard, S. K., Mac, D. T., Wang, C., Kwan, S., Rosekind, M. R.….Gaba, D.M. (2006). Improving alertness and performance in emergency department physicians and nurses: The use of planned naps. *Annals of Emergency Medicine, 48*(5), 596-604. doi:10.1016/j.nnemergme.2006.02.005

State of Wisconsin v. Thao, 2006CF002512, (WCCA, 2006).

Stone, P., Mooney-Kane, C., Larson, E., Horan, T., Zwanziger, J., & Dick, A.W. (2007). Nurse working conditions and patient safety outcomes. *Medical Care, 45*(6), 571-578. doi:10.1097/MLR.0b013e3180383667

Sussman D., & Coplen M. (2000). *Fatigue and alertness in the United States railroad industry Part 1: The nature of the problem.* Retrieved from http://www.volpe.dot.gov/opsad/sataprbm.html

Suzuki, K., Takashi, O., Kaneita, Y., Yokoyama, E., & Uchiyama, M. (2005). Daytime sleepiness, sleep habits and occupational accidents among hospital nurses. *Journal of Advanced Nursing, 52*(4), 445-453.

Tabone, S. (2004). Data suggest nurse fatigue threatens patient safety. *Texas Nurse 78*(2), 4-7.

Texas Board of Nursing. (2007a). *Nursing offer feedback on proposed nursing work hours position statement.* Retrieved from http://www.bne.state.tx.us/practice/pdfs/nwh-summary.pdf

Texas Board of Nursing. (2007b). Texas Administrative Code Title 22 Part II Chapter 217 §217.11 Standards of Nursing Practice. Retrieved from http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=22&pt=11&ch=217&rl=11

The Joint Commission. (2010). *Accreditation program: Hospital national patient safety goals.* Retrieved from http://www.jointcommission.org/assets/1/6/2011_NPSGs_HAP.pdf

The Joint Commission. (2011a). *Sentinel event alert.* Retrieved from http://www.jointcommission.org/assets/1/18/SEA_48.pdf

The Joint Commission. (2011b). *Sentinel events.* Retrieved from http://www.jointcommission.org/assets/1/6/2011_CAMH_SE.pdf

The Joint Commission. (2013*). National Patient Safety Goals Effective January 1, 2013.* Retrieved from http://www.jointcommission.org/assets/1/18/NPSG_Chapter_Jan2013_HAP.pdf

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., Johantgen, M., Storr, C. L., Gureses, A. P., Liang, Y., & Han, K., (2011a). Linking nurse work environment and patient outcomes. *Journal of Nursing Regulation 2*(1), 10-16.

Trinkoff, A. M., Johantgen, M., Storr, C. L., Gureses, A. P., Liang, Y., & Han, K., (2011b). Nurses' work schedule characteristics, nurse staffing, and patient mortality. *Nursing Research 60*(1), 1-8.

Trinkoff, A. M., Le, R., Geiger-Brown, J., & Lipscomb, J. (2007). Work schedule, needle use and needlestick injuries among registered nurses. *Infection Control and Hospital Epidemiology, 28*, 156-164.

Trinkoff, A.M., Le, R., Geiger-Brown, J., & Lipscomb, J., & Lang, G. (2006). Longitudinal relationship of work hours, mandatory overtime, and on-call to musculoskeletal problems in nurses. *American Journal of IndustrialMedicine, 49*, 964-971. doi:10.1002/ajim.20330

United States Census. (2010). The white population: 2010. Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-05.pdf

United States Department of Health and Human Services. (2008). National Samples Survey of Registered Nurses. Retrieved from http://datawarehouse.hrsa.gov/nursingsurvey.aspx

United States Department of Labor, Bureau of Labor Statistics. (2011). Survey Methods and Reliability Statement for the May 2011 Occupational Employment Statistics Survey. Retrieved from http://www.bls.gov/oes/2011/may/methods_statement.pdf

Van Dongen, H. P., & Dinges, D. F. (2005). Sleep, circadian rhythms, and psychomotor vigilance. *Clinical Sports Medicine 24*, 237-249.

Van Dongen, H. P., Maislin, G., Mullington, J. M., & Dinges, D. F. (2003). The cumulative cost of additional wakefulness: Dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep, 26*(2), 117-126.

Vila, B. (2006). Impact of long work hours on police officers and the communities they serve. *American Journal of Industrial Medicine, 49*, 972-980. doi:10.1002/ajim.20333

Virtanen, M., Ferrie, J. E., Gimeno, D., Vahlera, J., Elovainio, M., Singh-Manoux, A.…Kivimäki, M. (2009). Long working hours and sleep disturbances: The Whitehall II prospective cohort study. *Sleep, 32*(6), 737-745.

Wallack, M. K., & Chao, L. (2001). Resident work hours. *Archives of Surgery, 136*,1426-1432.

Waersted, M., & Westgaard, R. H. (1991). Working hours as a risk factor in the development of musculoskeletal complaints. *Ergonomics 34*(3), 265-276.

Watkins, A. M. (2010). *The impact of fatigue on medication errors by registered nurses* (Doctoral dissertation). California State University, Long Beach, CA.

Williamson, A. M., & Feyer, A. M. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. *Occupational Environmental Medicine, 57*, 649-655.

Williamson, A., Lombardi, D. A., Folkard, S., Stutts, J., Courtney, T. K., & Connor, J. L. (2011). The link between fatigue and safety. *Accident Analysis and Prevention 43*, 498-515. doi:10.1016/j.aap.2009.11.011

Winwood, P. C. & Lushington, K. (2006). Disentrangeling the effects of psychological and physical work demands on sleep, recovery and maladaptive chronic stree outcomes within a large sample of Australian nurses. *Journal of Advanced Nursing, 56*(6), 679-689.

Wisconsin Department of Regulations and Licensing. (2006). *Access to the public records of the reports of decisions.* Retrieved from https://online.drl.wi.gov/decisions/2006/ls0612145nur-00075545.pdf

Wisconsin Hospital Association, Inc. (*n.d.). Principles relating to health care work environment and fatigue.* Retrieved from http://www.wha.org/toolKit/fatiguepaper.pdf

Wisconsin Organization of Nurse Executives. (2008). *White paper: Nurse scheduling and fatigue in the acute care 24 hour setting.* Retrieved from http://www.w-one.org/uploads/FatiguePaper1-10-08.pdf

Wisher, R. A., & Olson, T. M. (2003). The effectiveness of web-based training. *Research report 1802; U.S. Army Research Institute for the Behavioral and Social Sciences.* Retrieved from http://www.hqda.army.mil/ari/pdf/rr-1802.pdf

Yager, T. (2009). Federal motor carrier safety administration. *Commercial Motor Vehicle Drivers'Hours of Service.* Retrieved from mcsac.fmcsa.dot.gov/documents/Hours_of_Service_History_and_Overview.ppt

Yates, G. R., Bernd, D. L., Sayles, S. M., Stockmeier, C. A., Burke, G., & Merti, G. E. (2005). Building and sustaining a systemwide culture of safety. *The Joint Commission Journal on Quality and Patient Safety, 31*(12), 684-689.

Appendix A

Advocate, Good Shepherd Waking up to Safety Survey

Advocate, Good Shepherd Waking up to Safety Survey

TO CONFIRM YOUR ELIGIBILTY, PLEASE ANSWER THE FOLLOWING QUESTIONS:

1. Are you a registered nurse clinically providing direct patient care?

   ☐ Yes ☐ No

2. Do you work in a unit that has 24 hour patient care responsibility?

   ☐ Yes ☐ No

IF ALL ABOVE QUESTIONS ARE ANSWERED YES, PLEASE COMPLETE THE QUESTIONS BELOW. IF NO IS ANSWERED TO ANY OF THE ABOVE QUESTIONS DO NOT CONTINUE THIS SURVEY.

DEMOGRAPHICS

1. For survey purposes only, list the day of your birth day followed by the last 4 numbers of your social security. For example if your date of birth is August 5th and your social security last four digits is 9999; enter 059999. If you prefer not to use these numbers, put in any numbers or letters that you will remember.

2. What academic degrees did you earn? Do not include degrees you are currently working toward. (Check all that apply)

   ☐ Associate Degree in Nursing
   ☐ Associate Degree in Non-nursing
   ☐ Diploma Nursing
   ☐ Bachelors Degree in Nursing
   ☐ Bachelors Degree in Non-nursing
   ☐ Masters Degree in Nursing
   ☐ Masters Degree in Non-nursing
   ☐ Doctoral Degree in Nursing
   ☐ Doctoral Degree in Non-nursing

3. What is your location of basic (level entry) nursing education?

 ☐ In the United States
 ☐ Outside of the United States (if checked state location)

4. For your principle nursing position what level of care or type of work do you spend your majority of time?(Check only one)

 ☐ Critical/Intensive Care
 ☐ Emergency
 ☐ Medical
 ☐ Medical/Surgical
 ☐ Neonatal
 ☐ Obstetrics
 ☐ Orthopedics
 ☐ Pediatric
 ☐ Surgical
 ☐ Telemetry
 ☐ Other – please describe ___________________

5. For this question count only the years that you have worked at least 50% of the calendar year as a Registered Nurse. How many years have you worked as a Registered Nurse

 Years if one or more
 ☐ Less than one year

6. For the primary clinical nursing position you hold what is your status?

 ☐ Full Time (scheduled 36 hours per week or greater)
 ☐ Part Time (scheduled hours less than 36 hours per week)
 ☐ Without Committed Hours (00)

7. In the last TWO months how many hours were you typically scheduled in a day?

 ☐ 4 Hours ☐ 8 Hours ☐ 10 Hours ☐ 12 Hours ☐ Other ________

8. In the last TWO months how many hours did you typically work in a day?

- ☐ < 8 hours
- ☐ 8 to 8 l/2 hours
- ☐ 9 to 9 l/2 hours
- ☐ 10 to 10 l/2 hours
- ☐ 11 to 11 l/2 hours
- ☐ 12 to 12 l/2 hours
- ☐ 13 to 13 l/2 hours
- ☐ 14 to 14 l/2 hours
- ☐ 15 to 15 l/2 hours
- ☐ 16 to 16 l/2 hours
- ☐ > 16 l/2 hours

9. What shift are you typically scheduled? (choose one)

☐ Days ☐ Evenings ☐ Nights ☐ Rotating

10. During the last TWO months, in a typical **week** how many hours did you currently work at your primary nursing position including overtime?

11. Other than your primary nursing position, do you hold any other jobs?

☐ Yes ☐ No

If yes, during the last TWO months in a typical **week** how many hours did you currently work at your additional job including overtime? (Do not include hours worked at your primary position)

12. What is your gender?

- ☐ Female
- ☐ Male

13. Which one or more would you like to use to describe your race?

- ☐ White or Caucasian
- ☐ Black or African American
- ☐ Asian
- ☐ Hispanic/Latino
- ☐ American Indian or Alaska Native
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other (please describe) ___________

14. Describe the children/parents/dependents who either live at home with you or for whom you provide a significant amount of care. Mark all that apply.

- ☐ No children/parents/dependents live at home
- ☐ Child(ren) less than 6 years old at home
- ☐ Child(ren) 6 to18 years of age at home
- ☐ Other adults at home (parents or dependents)
- ☐ Others living elsewhere (i.e. children, parents, dependents)

QUESTIONS –Please circle only one response.

1. In the past TWO months, I slept at least 6 hours prior to coming to work.

   Strongly Agree Agree Disagree Strongly Disagree

2. In the past TWO months, I slept at least 8 hours prior to coming to work.

   Strongly Agree Agree Disagree Strongly Disagree

3. In the past TWO months, I took naps when drowsiness set in and I knew I had to perform a high risk activity such as driving.

   Strongly Agree Agree Disagree Strongly Disagree N/A

4. In the past TWO months, I restricted my work hours to a maximum of 50 hours per week with all jobs I work.

   Strongly Agree Agree Disagree Strongly Disagree

5. In the past TWO months, I limited my work schedule (including all jobs) to a maximum of three days in a row (if working 12-hour shifts) or 5 days in a row (if working 8-hour shifts).

   Strongly Agree Agree Disagree Strongly Disagree

6. In the past TWO months, I limited my caffeine intake four hours prior to going to sleep.

   Strongly Agree Agree Disagree Strongly Disagree N/A

7. In the past TWO months, I took a 30 minute break at work.

   Strongly Agree Agree Disagree Strongly Disagree

8. In the past TWO months, when tired at work I used the wingman concept (I asked a co-worker to check my work).

   Strongly Agree Agree Disagree Strongly Disagree

9. In the past TWO months, I used STAR (stop, think, act, review) at work when drowsiness occurred.

   Strongly agree Agree Disagree Strongly Disagree N/A

10. In the past TWO months, I used critical thinking behavioral expectations such as Qualify, Validate, and Verify when fatigued.

    Strongly agree Agree Disagree Strongly Disagree

11. In the past TWO months, I followed a set scheduled work, sleep, eating pattern.

    Strongly agree Agree Disagree Strongly Disagree

12. It is obvious to me when my co-workers do not get enough rest.

    Strongly agree Agree Disagree Strongly Disagree

Appendix B

Advocate, Good Shepherd Waking up to Safety Post Survey

Advocate, Good Shepherd Waking up to Safety Post Survey

You are being asked to participate in a research project conducted with Advocate Healthcare and Olivet Nazarene University. The purpose of this study is to determine if work hour guidelines and education regarding safety risks have an impact on nurses extended duty time, fatigue management practices, and patient outcomes. You are invited to participate in this research project because you are a registered nurse working in a 24-hour patient care unit.

Your participation in this research study is voluntary. You are under no obligation. If you decide not to participate in this study or if you withdraw from this study, you will not be affected in any way.

As a participant, you will be asked to complete a written survey which will take approximately 5 minutes. You will be asked about your work history and interventions you utilize to improve alertness. Completion of this study will be while you are at work during your regular duty time.

Your responses will be anonymous. You will be asked to code your survey for the sole purpose of comparing data over time. Your identity in this study is not traced and information will be kept confidential. Results of this study will be used for scholarly purposes. Compiled data will be kept on a password protected computer program. Any manual data will be kept in a locked cabinet for three years.

This study has been approved and monitored according to Federal Law by the Institutional Review Board. The research project is one of minimal risk, one of inconvenience or perhaps emotional uncertainty; however, it is not possible to identify all potential risks. No direct benefits can be guaranteed by your participation.

If you have any questions about the research study, or would prefer a signed written consent form, or if you wish to withdraw from the study please contact Bonnie Schleder at 847-842-4109. There is no conflict of interest on the part of the primary investigator.

By completing this survey the following applies:
- **you have read the above information**
- **you voluntarily agree to participate**
- **you are at least 18 years of age**

If you do not wish to participate in the research study, please return the form without the information completed.

Advocate, Good Shepherd Waking up to Safety Survey

TO CONFIRM YOUR ELIGIBILTY FOR THIS RESEARCH PROJECT, PLEASE ANSWER THE FOLLOWING QUESTIONS:

1. Are you a registered nurse clinically providing direct patient care?

   ☐ Yes ☐ No

2. Do you work in a unit that has 24 hour patient care responsibility?

   ☐ Yes ☐ No

3. Did you view the required computer based training program called “Stay Alert/Stay Alive”?

   ☐ Yes ☐ No

IF ALL ABOVE QUESTIONS ARE ANSWERED YES, PLEASE COMPLETE THE QUESTIONS BELOW. IF NO IS ANSWERED TO ANY OF THE ABOVE QUESTIONS DO NOT CONTINUE THIS SURVEY.

DEMOGRAPHICS

1. For survey purposes only, list the day of your birth day followed by the last 4 numbers of your social security. For example if your date of birth is August 5th and your social security last four digits is 9999; enter 059999. If you prefer not to use these numbers, put in any numbers or letters that you will remember.

2. What academic degrees did you earn? Do not include degrees you are currently working toward. (Check all that apply)

   ☐ Associate Degree in Nursing
   ☐ Associate Degree in Non-nursing
   ☐ Diploma Nursing
   ☐ Bachelors Degree in Nursing
   ☐ Bachelors Degree in Non-nursing
   ☐ Masters Degree in Nursing
   ☐ Masters Degree in Non-nursing
   ☐ Doctoral Degree in Nursing
   ☐ Doctoral Degree in Non-nursing

3. What is your location of basic (level entry) nursing education?

☐ In the United States
☐ Outside of the United States (if checked state location)

4. For your principle nursing position what level of care or type of work do you spend your majority of time?(Check only one)

☐ Critical/Intensive Care
☐ Emergency
☐ Medical
☐ Medical/Surgical
☐ Neonatal
☐ Obstetrics
☐ Orthopedics
☐ Pediatric
☐ Surgical
☐ Telemetry
☐ Other – please describe __________________

5. For this question count only the years that you have worked at least 50% of the calendar year as a Registered Nurse. How many years have you worked as a Registered Nurse

Years if one or more
☐ Less than one year

6. For the primary clinical nursing position you hold what is your status?

☐ Full Time (scheduled 36 hours per week or greater)
☐ Part Time (scheduled hours less than 36 hours per week)
☐ Without Committed Hours (00)

7. In the last TWO months how many hours were you typically scheduled in a day?

☐ 4 Hours ☐ 8 Hours ☐ 10 Hours ☐ 12 Hours ☐ Other ________

8. In the last TWO months how many hours did you typically work in a day?

- □ < 8 hours
- □ 8 to 8 l/2 hours
- □ 9 to 9 l/2 hours
- □ 10 to 10 l/2 hours
- □ 11 to 11 l/2 hours
- □ 12 to 12 l/2 hours
- □ 13 to 13 l/2 hours
- □ 14 to 14 l/2 hours
- □ 15 to 15 l/2 hours
- □ 16 to 16 l/2 hours
- □ > 16 l/2 hours

9. What shift are you typically scheduled? (choose one)

□ Days □ Evenings □ Nights □ Rotating

10. During the last TWO months, in a typical **week** how many hours did you currently work at your primary nursing position including overtime?

11. Other than your primary nursing position, do you hold any other jobs?

□ Yes □ No

If yes, during the last TWO months in a typical **week** how many hours did you currently work at your additional job including overtime? (Do not include hours worked at your primary position)

12. What is your gender?

- □ Female
- □ Male

13. Which one or more would you like to use to describe your race?

- ☐ White or Caucasian
- ☐ Black or African American
- ☐ Asian
- ☐ Hispanic/Latino
- ☐ American Indian or Alaska Native
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other (please describe) ___________

14. Describe the children/parents/dependents who either live at home with you or for whom you provide a significant amount of care. Mark all that apply.

- ☐ No children/parents/dependents live at home
- ☐ Child(ren) less than 6 years old at home
- ☐ Child(ren) 6 to18 years of age at home
- ☐ Other adults at home (parents or dependents)
- ☐ Others living elsewhere (i.e. children, parents, dependents)

<u>QUESTIONS –Please circle only one response.</u>

15. In the past TWO months, I slept at least 6 hours prior to coming to work.

Strongly Agree   Agree   Disagree   Strongly Disagree

16. In the past TWO months, I slept at least 8 hours prior to coming to work.

Strongly Agree   Agree   Disagree   Strongly Disagree

17. In the past TWO months, I took naps when drowsiness set in and I knew I had to perform a high risk activity such as driving.

Strongly Agree   Agree   Disagree   Strongly Disagree   N/A

18. In the past TWO months, I restricted my work hours to a maximum of 50 hours per week with all jobs I work.

Strongly Agree   Agree   Disagree   Strongly Disagree

19. In the past TWO months, I limited my work schedule (including all jobs) to a maximum of three days in a row (if working 12-hour shifts) or 5 days in a row (if working 8-hour shifts).

Strongly Agree   Agree   Disagree   Strongly Disagree

20. In the past TWO months, I limited my caffeine intake four hours prior to going to sleep.

Strongly Agree　　Agree　　Disagree　　Strongly Disagree　　N/A

21. In the past TWO months, I took a 30 minute break at work.

Strongly Agree　　Agree　　Disagree　　Strongly Disagree

22. In the past TWO months, when tired at work I used the wingman concept (I asked a co-worker to check my work).

Strongly Agree　　Agree　　Disagree　　Strongly Disagree

23. In the past TWO months, I used STAR (stop, think, act, review) at work when drowsiness occurred.

Strongly agree　　Agree　　Disagree　　Strongly Disagree　　N/A

24. In the past TWO months, I used critical thinking behavioral expectations such as Qualify, Validate, and Verify when fatigued.

Strongly agree　　Agree　　Disagree　　Strongly Disagree

25. In the past TWO months, I followed a set scheduled work, sleep, eating pattern.

Strongly agree　　Agree　　Disagree　　Strongly Disagree

26. It is obvious to me when my co-workers do not get enough rest.

Strongly agree　　Agree　　Disagree　　Strongly Disagree

Appendix C

Advocate, Condell Waking up to Safety Survey

Advocate, Condell Waking up to Safety Survey

You are being asked to participate in a research project conducted with Advocate Healthcare and Olivet Nazarene University. The purpose of this study is to determine if work hour guidelines and education regarding safety risks have an impact on nurses extended duty time, fatigue management practices, and patient outcomes. You are invited to participate in this research project because you are a registered nurse working in a 24-hour patient care unit.

Your participation in this research study is voluntary. You are under no obligation. If you decide not to participate in this study or if you withdraw from this study, you will not be affected in any way.

As a participant, you will be asked to complete a written survey which will take approximately 5 minutes. You will be asked about your work history and interventions you utilize to improve alertness. Completion of this study will be while you are at work during your regular duty time.

Your responses will be anonymous. You will be asked to code your survey for the sole purpose of comparing data over time. Your identity in this study is not traced and information will be kept confidential. Results of this study will be used for scholarly purposes. Compiled data will be kept on a password protected computer program. Any manual data will be kept in a locked cabinet for three years.

This study has been approved and monitored according to Federal Law by the Institutional Review Board. The research project is one of minimal risk, one of inconvenience or perhaps emotional uncertainty; however, it is not possible to identify all potential risks. No direct benefits can be guaranteed by your participation.

If you have any questions about the research study, or would prefer a signed written consent form, or if you wish to withdraw from the study please contact Bonnie Schleder at 847-842-4109. There is no conflict of interest on the part of the primary investigator.

By completing this survey the following applies:
- **you have read the above information**
- **you voluntarily agree to participate**
- **you are at least 18 years of age**

If you do not wish to participate in the research study, please return the form without the information completed.

Condell Waking up to Safety Survey

TO CONFIRM YOUR ELIGIBILTY FOR THIS RESEARCH PROJECT, PLEASE ANSWER THE FOLLOWING QUESTIONS:

1. Are you a registered nurse clinically providing direct patient care?

   ☐ Yes ☐ No

2. Do you work in a unit that has 24 hour patient care responsibility?

   ☐ Yes ☐ No

IF BOTH ABOVE QUESTIONS ARE ANSWERED YES, PLEASE COMPLETE THE QUESTIONS BELOW. IF NO IS ANSWERED TO ANY OF THE ABOVE QUESTIONS DO NOT CONTINUE THIS SURVEY.

DEMOGRAPHICS

1. For survey purposes only, list the day of your birth day followed by the last 4 numbers of your social security. For example if your date of birth is August 5th and your social security last four digits is 9999; enter 059999. If you prefer not to use these numbers, put in any numbers or letters that you will remember.

2. What academic degrees did you earn? Do not include degrees you are currently working toward. (Check all that apply)

   ☐ Associate Degree in Nursing
   ☐ Associate Degree in Non-nursing
   ☐ Diploma Nursing
   ☐ Bachelors Degree in Nursing
   ☐ Bachelors Degree in Non-nursing
   ☐ Masters Degree in Nursing
   ☐ Masters Degree in Non-nursing
   ☐ Doctoral Degree in Nursing
   ☐ Doctoral Degree in Non-nursing

3. What is your location of basic (level entry) nursing education?

   ☐ In the United States
   ☐ Outside of the United States (if checked state location)

4. For your principle nursing position what level of care or type of work do you spend your majority of time?(Check only one)

- ☐ Critical/Intensive Care
- ☐ Emergency
- ☐ Medical
- ☐ Medical/Surgical
- ☐ Neonatal
- ☐ Obstetrics
- ☐ Orthopedics
- ☐ Pediatric
- ☐ Surgical
- ☐ Telemetry
- ☐ Other – please describe ___________________

5. For this question count only the years that you have worked at least 50% of the calendar year as a Registered Nurse. How many years have you worked as a Registered Nurse

Years if one or more

- ☐ Less than one year

6. For the primary clinical nursing position you hold what is your status?

- ☐ Full Time (scheduled 36 hours per week or greater)
- ☐ Part Time (scheduled hours less than 36 hours per week)
- ☐ Without Committed Hours (00)

7. In the last TWO months how many hours were you typically scheduled in a day?

☐ 4 Hours ☐ 8 Hours ☐ 10 Hours ☐ 12 Hours ☐ Other _________

8. In the last TWO months how many hours did you typically work in a day?

- ☐ < 8 hours
- ☐ 8 to 8 l/2 hours
- ☐ 9 to 9 l/2 hours
- ☐ 10 to 10 l/2 hours
- ☐ 11 to 11 l/2 hours
- ☐ 12 to 12 l/2 hours
- ☐ 13 to 13 l/2 hours
- ☐ 14 to 14 l/2 hours
- ☐ 15 to 15 l/2 hours
- ☐ 16 to 16 l/2 hours
- ☐ > 16 l/2 hours

9. What shift are you typically scheduled? (choose one)

☐ Days ☐ Evenings ☐ Nights ☐ Rotating

10. During the last TWO months, in a typical **week** how many hours did you currently work at your primary nursing position including overtime?

11. Other than your primary nursing position, do you hold any other jobs?

☐ Yes ☐ No

If yes, during the last TWO months in a typical **week** how many hours did you currently work at your additional job including overtime? (Do not include hours worked at your primary position)

12. What is your gender?

☐ Female
☐ Male

13. Which one or more would you like to use to describe your race?

☐ White or Caucasian
☐ Black or African American
☐ Asian
☐ Hispanic/Latino
☐ American Indian or Alaska Native
☐ Native Hawaiian or Other Pacific Islander
☐ Other (please describe) ___________

14. Describe the children/parents/dependents who either live at home with you or for whom you provide a significant amount of care. Mark all that apply.

☐ No children/parents/dependents live at home
☐ Child(ren) less than 6 years old at home
☐ Child(ren) 6 to18 years of age at home
☐ Other adults at home (parents or dependents)
☐ Others living elsewhere (i.e. children, parents, dependents)

QUESTIONS –Please circle only one response.

15. In the past TWO months, I slept at least 6 hours prior to coming to work.

    Strongly Agree   Agree   Disagree   Strongly Disagree

16. In the past TWO months, I slept at least 8 hours prior to coming to work.

    Strongly Agree   Agree   Disagree   Strongly Disagree

17. In the past TWO months, I took naps when drowsiness set in and I knew I had to perform a high risk activity such as driving.

    Strongly Agree   Agree   Disagree   Strongly Disagree   N/A

18. In the past TWO months, I restricted my work hours to a maximum of 50 hours per week with all jobs I work.

    Strongly Agree   Agree   Disagree   Strongly Disagree

19. In the past TWO months, I limited my work schedule (including all jobs) to a maximum of three days in a row (if working 12-hour shifts) or 5 days in a row (if working 8-hour shifts).

    Strongly Agree   Agree   Disagree   Strongly Disagree

20. In the past TWO months, I limited my caffeine intake four hours prior to going to sleep.

    Strongly Agree   Agree   Disagree   Strongly Disagree   N/A

21. In the past TWO months, I took a 30 minute break at work.

    Strongly Agree   Agree   Disagree   Strongly Disagree

22. In the past TWO months, when tired at work I used the wingman concept (I asked a co-worker to check my work).

    Strongly Agree   Agree   Disagree   Strongly Disagree

23. In the past TWO months, I used STAR (stop, think, act, review) at work when drowsiness occurred.

    Strongly agree   Agree   Disagree   Strongly Disagree   N/A

24. In the past TWO months, I used critical thinking behavioral expectations such as Qualify, Validate, and Verify when fatigued.

Strongly agree Agree Disagree Strongly Disagree

25. In the past TWO months, I followed a set scheduled work, sleep, eating pattern.

Strongly agree Agree Disagree Strongly Disagree

26. It is obvious to me when my co-workers do not get enough rest.

Strongly agree Agree Disagree Strongly Disagree

APPENDIX D

Survey Data

Table 16

Demographic Information

	Group I		Group II		Group III		Group IV	
Variable	*n*	Valid%	*n*	Valid%	*n*	Valid %	*n*	Valid %
Gender								
Female	198	94.7%	182	93.3%	174	91.1%	76	95.0%
Male	11	5.3%	13	6.7%	17	8.9%	4	5.0%
Race								
Caucasian	155	74.9%	152	77.6%	124	64.9%	63	79.7%
African American	4	1.9%	4	2.0%	2	1.0%	1	1.3%
Asian	42	20.3%	38	19.4%	50	26.2%	13	16.5%
Hispanic/Latino	5	2.4%			11	5.8%	1	1.3%
Other	1	0.5%	2	1.0%	4	2.1%	1	1.3%

Table 17

Educational Information

	Group I		Group II		Group III		Group IV	
Variable	*n*	Valid %	*n*	Valid %	*n*	Valid%	*n*	Valid%
Degree								
Associate	73	35.5%	63	32.3%	63	33.2%	29	36.3%
Diploma	5	2.6%	9	60.5%			5	6.2%
Bachelors	114	55.6%	118	2.6%	116	61.1%	44	55.0%
Masters	13	6.4%	5	4.6%	11	5.8%	2	2.5%
Initial Nursing Education								
In USA	175	84.5%	167	85.2%	159	84.1%	70	87.5%
Outside USA	30	14.5%	28	14.3%	30	15.9%	9	11.3%
Both	2	1.0%	1	0.5%			1	1.3%

Table 18

Work Information

	Group I		Group II		Group III		Group IV	
Variable	*n*	Valid %	*n*	Valid %	*n*	Valid %	*n*	Valid %
Years as a Registered Nurse								
0 – 10 Years	84	39.7%	76	39.0%	101	53.4%	29	36.3%
11 – 20 Years	69	33.0%	61	31.3%	46	24.4%	26	32.5%
21 – 30 Years	41	19.6%	44	22.5%	27	14.3%	16	20.0%
31 – 40 Years	14	6.7%	10	5.1%	15	7.9%	8	10.0%
>40 Years	2	1.0%	4	2.1%			1	1.3%
Status								
Full Time	154	73.3%	155	79.1%	144	75.8%	58	72.5%
Part Time	50	23.8%	38	19.4%	36	18.9%	20	25.0%
Other	6	2.9%	3	1.5%	10	5.3%	2	2.5%

Table 18

Work Information (Continued)

Variable	Group I *n*	Group I Valid %	Group II *n*	Group II Valid %	Group III *n*	Group III Valid %	Group IV *n*	Group IV Valid %
Shift								
Days	104	49.5%	92	47.2%	93	48.7%	33	41.3%
Evening	16	7.6%	11	5.6%	25	13.1%	4	5.0%
Nights	80	38.1%	82	42.1%	53	27.7%	38	47.5%
Rotating	10	4.8%	10	5.1%	20	10.5%	5	6.3%
Scheduled Hours								
4 Hours	1	0.5%						
8 Hours	18	8.6%	12	6.1%	55	28.9%	7	8.8%
10 Hours	3	1.4%			3	1.6%		
12 Hours	183	87.1%	179	91.3%	125	65.8%	70	87.5%
Other/ 8 & 12 Hrs	5	2.4%	5	2.6%	7	3.7%	3	3.8%

Table 18

Work Information (Continued)

Variable	Group I *n*	Group I Valid %	Group II *n*	Group II Valid %	Group III *n*	Group III Valid %	Group IV *n*	Group IV Valid %
Additional Job								
Yes	47	22.7%	35	17.9%	41	21.8%	19	24.1%
No	160	77.3%	160	82.1%	147	78.2%	60	75.9%
Specialty								
Critical Care	59	28.1%	60	30.8%	34	17.9%	28	35.0%
Emergency	31	14.8%	22	11.3%	25	13.2%	10	12.5%
Medical/Surgical	39	14.3%	38	19.5%	44	23.2%	7	8.8%
Neonatal	11	5.2%	5	2.6%	3	1.6%	5	6.2%
Obstetrics	27	12.9%	27	13.8%	23	12.1%	12	15.0%
Orthopedics	9	4.3%	3	1.5%			4	5.0%
Pediatrics	1	0.5%			5	2.6%		
Telemetry	27	12.9%	20	10.3%	26	13.7%	9	11.3%
Other/Multiple	15	7.1%	20	10.3%	30	15.8%	5	6.2%

Table 19

Family Commitment

Variable	Group I *n*	Group I Valid %	Group II *n*	Group II Valid %	Group III *n*	Group III Valid %	Group IV *n*	Group IV Valid %
No Responsibility For Child/Adults	49	23.4%	47	24.4%	53	27.8%	15	19.0%
Responsible for Child/Children	89	42.6%	84	43.6%	74	38.7%	27	34.2%
Responsible for Adults	39	18.7%	32	16.6%	30	15.7%	18	22.8%
Responsible for Child & Adults	32	15.3%	30	15.5%	34	17.8%	19	24.0%

APPENDIX E

Fatigue Management Countermeasures

Table 20

Fatigue Management Countermeasures

One Way ANOVA – Tukey post hoc	Group I		Group II		Group III		
	Mean	S*SD*	Mean	S*SD*	Mean	S*SD*	*F*-score
Personal Behavior Countermeasures							
Slept at least 6 hours	2.94	.85	2.92	0.86	2.96	0.79	0.111
Slept at least 8 hours	2.21	0.87	2.22	0.89	2.28	0.90	0.349
Took naps when drowsy	2.24	0.84	2.19	0.99	2.16	1.07	0.302
Limited caffeine intake prior to sleep	2.68	0.98	2.70	1.06	2.47	1.13	2.823
Followed a set schedule	2.56	0.92	2.66	0.79	2.65	0.87	0.970
Personal Behavior Total	11.98	2.82	12.59	2.40	12.50	2.87	3.011
Work Hour Countermeasures							
Restricted work hours to 50 hours per week	3.05	0.90	3.16	0.88	2.95	1.00	2.512
Limited days in a row work schedule	2.96	0.97	3.21	0.81	2.83	0.95	8.600**
Took a 30 minute break at work	2.44	0.89	2.56	0.86	2.35	0.90	2.800
Work Hour Total	8.27	2.06	8.87	1.72	8.09	2.15	8.294**

Table 20

Fatigue Management Countermeasures (Continued)

One Way ANOVA – Tukey post hoc	Group I		Group II		Group III		
	Mean	*SD*	Mean	*SD*	Mean	*SD*	*F*-score
Safety Behavior Countermeasures							
Utilized Wingman Concept when fatigued	2.56	0.85	2.62	0.82	2.06	1.14	19.422**
Utilized Stop, Think, Act, Review when drowsy	3.01	0.72	3.05	0.64	2.52	1.23	20.258**
Utilized Qualify, Validate, Verify when fatigued	3.05	0.64	3.15	0.58	2.94	0.92	18.041**
Safety Behavior Total	7.78	2.94	8.18	2.75	7.17	3.43	5.401**
Total of All Countermeasures	28.03	5.27	29.64	4.23	27.75	5.76	7.758**

* $p < .05$

** $p < .01$

Table 21

Fatigue Management Countermeasures-Group IV

Paired Samples *t*-Test	Pre (n = 80) Mean	Pre (n = 80) *SD*	Post (n = 80) Mean	Post (n = 80) *SD*	*t*-Score
Personal Behavior Countermeasures					
Slept at least 6 hours	3.04	0.81	3.05	0.86	-0.132
Slept at least 8 hours	2.19	0.75	2.27	0.97	-0.705
Took naps when drowsy	2.29	0.82	2.50	0.85	-1.649
Limited caffeine intake prior to sleep	2.65	0.97	2.80	0.99	-1.373
Followed a set schedule	2.54	0.93	2.66	0.70	-1.085
Personal Behavior Total	12.19	2.60	12.85	2.42	-2.222*
Work Hour Countermeasures					
Restricted work hours to 50	3.24	0.87	3.22	0.89	0.231
Limited days in a row work schedule	2.90	0.99	3.27	0.81	-3.772**
Took a 30 minute break at work	2.46	0.93	2.61	0.79	-1.404
Work Hour Total	8.58	1.99	9.01	1.80	-1.996*
Safety Behavior Countermeasures					
Utilized Wingman Concept	2.42	0.89	2.66	0.86	-2.162*
Utilized Stop, Think, Act, Review	2.99	0.69	3.07	0.59	-0.948
Utilized Qualify, Validate, Verify	3.06	0.66	3.11	0.58	-0.683
Safety Behavior Total	8.46	1.69	8.80	1.60	-1.614
Total of All Countermeasures	28.78	5.01	29.99	4.38	-2.122*

* $p < .05$
** $p < .01$

APPENDIX F

Self-Reported Hours Worked

Table 22

Self-Reported Hours Worked

One Way ANOVA		Group I			Group II			Group III			
Tukey post hoc	*n*	Range	Mean	*SD*	Range	Mean	*SD*	Range	Mean	*SD*	*F*-score
Primary Hours	556	10 - 78	36.12	8.31	4 – 80	35.49	7.84	4 – 60	37.27	9.12	2.005
Secondary Hours	119	2 – 45	14.07	8.84	3 – 36	13.35	6.94	2 – 40	14.98	8.38	0.372
Total Hours	556	10 - 87	39.11	11.57	4 – 80	37.87	9.63	4 – 80	40.63	10.73	3.061*

* $P < .05$

** $P < .01$

Table 23

Self-Reported Hours Worked – Group IV

Paired Samples t-Test		Pre-intervention (*n* =70)			Post- intervention (*n* = 70)		
	Range	Mean	*SD*	Range	Mean	*SD*	*t*-Test
Primary Hours	10 - 60	35.47	7.04	12 - 42	34.57	6.73	1.405
Secondary Hours	4 - 32	12.27	6.92	4 - 32	12.27	6.92	--------
Total Hours	16 - 81	39.60	11.45	12- 69	37.03	8.86	1.896

* $p < .05$

** $p < .01$

APPENDIX G

Schedules Reflecting 12-Hour Shifts in a Row

Table 24

Schedules Reflecting Four

12-Hour Shifts in a Row

Crosstabs	June/July 2011 Research Hosp n=299	Jan/Feb 2012 Research Hosp n=312	Jan/Feb 2012 Control Hosp n=483	χ^2
Work Days Four 12-Hour Shifts in a Row	19(6.4%)	8(2.6%)	14(2.9%)	7.810*

*p < .05

** p < .01

Table 25

Schedules Reflecting Actual Work Hours

Four 12-Hour Shifts in a Row

Chi-Square	June/July 2011 Research Hosp n=299	Jan/Feb 2012 Research Hosp n=312	Jan/Feb 2012 Control Hosp n=483	χ^2
Four – 12-Hour Shifts in a Row	19	8		5.194*
Four – 12-Hour Shifts in a Row	19		14	5.457*
Four – 12-Hour Shifts in a Row		8	14	.079

* p < .05

**p < .01

Table 26

Schedules Reflecting Five

12-Hour Shifts in a Row

Crosstabs	June/July 2011 Research Hosp *n*=299	Jan/Feb 2012 Research Hosp *n*=312	Jan/Feb 2012 Control Hosp *n*=483	χ^2
Work Days Five 12-Hour Shifts in a Row	5(.02%)	4(01%)	2(.004%)	3.272

* $p < .05$

**$p < .01$

Table 27

Schedules Reflecting Actual Work Hours

Five 12-Hour Shifts in a Row

Chi-Square	June/July 2011 Research Hosp *n*=299	Jan/Feb 2012 Research Hosp *n*=312	Jan/Feb 2012 Control Hosp *n*=483	χ^2
Five – 12 Hour Shifts in a Row	5	4		.160
Five – 12 Hour Shifts in a Row	5		2	3.295
Five – 12 Hour Shifts in a Row		4	2	1.907

* $p < .05$

**$p < .01$

Table 28

Schedules Reflecting Actual Work Hours

Six 12-Hour Shifts in a Row

Chi-Square	June/July 2011 Research Hosp *n*=299	Jan/Feb 2012 Research Hosp *n*=312	Control Hosp *n*=483	χ^2
Six – 12 Hour				
Shifts in a Row	1			N/A

Table 29
Schedules Reflecting Actual Work Hours

Seven 12-Hour Shifts in a Row

Chi-Square	June/July 2011 Research Hosp *n=299*	Jan/Feb 2012 Research Hosp *n*=312	Control Hosp *n*=483	χ^2
Seven – 12 Hour				
Shifts in a Row	1			N/A