

Off-shift Nursing and Quality Patient Outcomes

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ABSTRACT

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Acute care hospitals function 24-hours-a-day, 7-days-a-week. A majority of that time is characterized as off-shifts (*i.e.*, nights, weekends, and/or holidays). Researchers have found that patient outcomes are generally worse on off-shifts as compared to regular hours. However, the underlying mechanism of why these outcomes are worse remains unclear. This dissertation explores off-shift care including nurse staffing and human capital variables and their impact on patient safety in acute care hospitals. The importance of off-shift quality care in acute care hospitals is discussed in the first chapter. In the second chapter, findings from a systematic literature review are presented. The third chapter describes mixed methods and the theoretical framework that guided the development of an interview guide and the quantitative portion of the dissertation. The fourth chapter includes the qualitative study of off-shift nursing and the fifth chapter, is a quantitative study of testing variations in nursing inputs (*i.e.*, staffing and human capital variables) by shift and their impact on length of stay. Finally, in the sixth chapter, the findings from Chapter 2, 4, and 5 are summarized and synthesized into a concluding chapter of the dissertation.

This dissertation was written in a mixed format, which includes versions of papers that have been or will be submitted to peer reviewed journals. These papers include the following: two submitted manuscripts which have been peer reviewed. One paper was revised and resubmitted, the other requires revisions. The third paper is a working paper. The three papers are:

1. Chapter 2, (Paper #1)

de Cordova, P. B., Phibbs, C., Bartel, A. P. & Stone, P. W. (submitted for publication). Twenty-four / seven: a systematic review of the off-shift literature. *Journal of Advanced Nursing*.

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2. Chapter 4, (Paper #2)

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3. Chapter 5, (Paper #3)

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Chapter 1: Introduction and Background

In this chapter, the importance of patient safety and nursing quality in hospitals is presented. Included in this chapter is the evidence supporting the association between nurse staffing and patient outcomes. The topic of off-shifts, the significance of the study and the gaps in the evidence, are discussed. This chapter concludes by presenting the aims of the dissertation and the potential contributions of this work to nursing science.

Patient Safety and Quality Care in Hospitals

Improving quality care in acute care hospitals is an important public health concern in the United States (US). In the 1999 landmark Institute of Medicine (IOM) Report, the IOM estimated that as many as 44,000 to 98,000 people die in US hospitals each year as the result of lapses in patient safety (Institute of Medicine, 1999). From this report, patient safety, an important aspect of overall quality of care, became one of the nation's most pressing healthcare challenges. Recognizing the importance of improving patient safety in hospitals, the Patient Safety and Quality Improvement Act was signed in 2005 to identify voluntary, provider-driven initiatives to improve quality, safety, and outcomes of patient care (Agency for Healthcare Research and Quality [AHRQ], 2009a).

Nurses, as providers, affect patient safety in all healthcare settings (Quigley, 2003). In a recent interview with the Chief Executive Officer of the American Organization of Nurse Executives, Ms. Pam A. Thompson stated that “nurses are at an intersection of where all work takes place and it is nursing responsibility for being an advocate for the patient around patient safety” (Muccigrosso, 2010). Nursing's participation in safety and quality initiatives have intensified, fueled by the expanding research on preventable hospital complications and their relationship to the level of nurse staffing, as well as realization that evidence-based practices may reduce certain poor outcomes (Harris, Vanderboom, & Hughes, 2009).

Eleven years later after the seminal IOM Report, researchers, administrators, and clinicians are still working towards improving patient safety and quality care. In the seventh annual HealthGrades, which is an independent Colorado organization that rates healthcare,

researchers evaluated 39.5 million hospitalization records from 5,000 nonfederal hospitals (Shapiro, 2010). Using 15 patient safety indicators from US Department of Health and Human Services' Agency for Healthcare Research and Quality (AHRQ), these researchers found among Medicare patients, that patient safety incidents resulted in 99,180 deaths and cost the Medicare program \$8.9 billion (Shapiro, 2010). Although there is increasing commitment among leaders as well as public awareness, there still needs to be improvements in the area of patient safety.

Recognizing the importance of nurses in promoting patient safety, several agencies have developed quality indicators and standards for nursing care. Agencies that have worked with nurses to develop standards include AHRQ, the National Quality Forum (NQF), the American Nurses Association (ANA), the American Hospital Association (AHA), and the Joint Commission (JC). Those standards, indicators, and outcomes that pertain to nursing care are often referred to as "nursing-sensitive." Patient outcomes and indicators that are nursing-sensitive are defined as changes in health status upon which nursing care has had a direct influence (International Council of Nurses, 2010). Nursing-sensitive indicators often reflect the structure, process, and outcomes of nursing care (American Nurses Association [ANA], 2010a). According to the ANA, the structure of nursing-sensitive indicators refer to the supply, the skill level, and the education/certification of nurses (ANA, 2010a). The process refers to some aspect of the delivery of nursing care (*e.g.*, the interaction between the nurse and patient), and the outcomes refer to measuring the quality of nursing care (ANA, 2010a).

The JC and the AHA are two hospital organizations also committed to improving patient safety and quality. These agencies work with nurses and other healthcare providers in developing hospital standards. The JC developed the National Patient Safety Goals. These goals include improving accuracy of identifying patients, communication, and medication

administration. The JC Goals also focus on decreasing nosocomial (*i.e.*, hospital-acquired) infections, falls, and pressure ulcers (Joint Commission [JC], 2010a). Together with these goals, the JC also helped to expand the NQF (JC, 2010b). The AHA committed itself to assisting healthcare providers, including nurses, to deliver safe, effective, and timely care to patients (American Hospital Association, 2010).

The NQF was created in 1999 as an organization in which researchers and administrators committed themselves to setting national priorities and goals for performance improvement (National Quality Forum [NQF], 2004). In 2004, the NQF developed 15 national voluntary consensus standards for nursing-sensitive care (NQF, 2004). The 15 standards were developed by a consensus process in order to achieve higher levels of patient safety and better outcomes for patients (NQF, 2004) These 15 standards (Table 1.1) are categorized into patient-centered outcome measures, nursing-centered intervention measures, and system-centered measures

Leaders in the ANA also committed themselves to improving nursing quality. In 1998, the ANA, the Midwest Research Institute, and the University of Kansas developed the National Database of Nursing Quality Indicators (NDNQI). The NDNQI is the only national nursing quality measurement program that provides hospitals with unit-level performance reports along with comparisons to national averages and percentile rankings (ANA, 2009). Besides for the formation of the NDNQI, the ANA also created a National Center for Nursing Quality in order to improve patient safety, nursing quality, and nurses' work lives (ANA, 2010).

Patient Safety Indicators and Nursing Quality

Researchers at AHRQ developed Patient Safety Indicator (PSIs) to measure healthcare quality and address patient safety in hospitals (AHRQ, 2009). The PSIs screen for problems that

patients experience as a result of exposure to the healthcare system, and that are likely amenable to prevention by changes at the system or provider level (AHRQ, 2003). The PSIs were developed as screening measures and are defined using administrative discharge data (AHRQ, 2009). There are currently 20 PSIs applicable to hospitalized patients (Table 1.2). Of the 20 hospital-level PSIs, eight of them are for surgical patients, 8 are for either medical or surgical patients, and 4 are for obstetric patients (Rivard et al., 2011). Some of these PSIs were identified as staffing sensitive and conceptually similar to the NQF measures. These include PSI 3 Pressure ulcer, PSI 4 Failure-to-rescue, PSI 7 Selected infections related to medical care (recently renamed Central venous catheter-related bloodstream infections), and PSI 12 Postoperative pulmonary embolism or deep vein thrombosis.

PSI 3 “Pressure ulcer” was used by Needleman et al. (2001) and identified as an “outcome potentially sensitive to nursing.” Additionally, the ANA, its State associations, and the California Nursing Outcomes Coalition have identified the total prevalence of inpatients with Stage I, II, III, or IV pressure ulcers as a “nursing-sensitive quality indicator for acute care settings” (ANA, 1999).

PSI 4, “Failure-to-rescue”, is defined as the inability to prevent a clinically important deterioration, such as death or permanent disability from a complication of an underlying illness or a complication of medical care (AHRQ, 2003). In the same study cited above, Needleman et al. (2001) found that higher registered nurse staffing (RN hours/adjusted patient day) and better nursing skill mix (RN hours/licensed nurse hours) were consistently associated with lower failure-to-rescue rates, even using administrative data to define complications.

The PSI 7, “Selected infections due to medical care” (recently modified and renamed) is also linked to nursing quality. The ANA and its State associations have identified the number of laboratory-confirmed bacteremic episodes associated with central lines per critical care patient day as a “nursing-sensitive quality indicator for acute care settings” (ANA, 1999).

Finally, the fourth PSI that may be linked to nursing quality is PSI 12 “Post-operative pulmonary embolism or deep vein thrombosis” (AHRQ, 2009). Previous research examining the effect of nurse staffing and pulmonary embolism/deep vein thrombosis has been inconsistent. In the study cited above, Needleman et al. (2001) found that nurse staffing was not associated with the occurrence of pulmonary embolism/deep vein thrombosis among both major surgical or medical patients. However, Kovner and Gergen (1998) reported that having more RN hours and non-RN hours was associated with a lower rate of pulmonary embolism/deep vein thrombosis after major surgery.

Nurse Staffing and Patient Outcomes

Nurse staffing is thought to be one of the key variables that influences patient safety outcomes (Clarke, 2007). Nurse staffing is often defined as specific numbers, proportions, or ratios of nurses to patients (Seago, 2010). Over the past few years, evidence has been accumulating supporting that higher levels of nurse staffing are associated with lower levels of adverse patient outcomes. In a recent meta-analysis, researchers pooled data from 96 studies and found that an increase of 1 registered nurse (RN) full-time equivalent per patient day was associated with a 9% reduction in the odds of a death in ICU patients, a 16% reduction in the odds of a death in surgical patients and a 6% reduction in the odds of a death in medical patients (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007). In response to this growing evidence, the

ANA developed policy statements and principles on “safe” nurse staffing (ANA, 2011).

Identifying what constitutes “safe” staffing is often challenging and debatable. According to the ANA, nurse staffing is most appropriate and meaningful when it considers the aggregate population of patients and the associated roles and responsibilities of nursing staff (ANA, 2011).

Introduction to Off-shifts

In hospitals, nurses work 24 hours-a-day, 7 days-a-week. To provide patient coverage, some nurses must work “off-shifts”, which include nights, weekends, and holidays. Nurse staffing on off-shifts may differ from nurse staffing on more regular hours. For example in two studies, researchers have found that fewer nurses at night is associated with increased risk of postoperative pulmonary complications and higher resource use in both hepatectomy and esophageal resection patients (Amaravadi, Dimick, Pronovost, & Lipsett, 2000; Dimick, Swoboda, Pronovost, & Lipsett, 2001). Additionally, nurses who work at night may suffer from sleep problems, which may impact patient safety. Furthermore, sleep deprivation jeopardizes not only patient safety, but also the safety and general health of nurses themselves (Rogers, Hwang, Scott, Aiken, & Dinges, 2004). It is often the second half of the night in which nurses reported that they frequently struggle to stay awake (Berger & Hobbs, 2006).

To ensure a sufficient number of nurses on off-shifts, some nurses who routinely work during the day may need to rotate to work at night. These nurses may suffer from sleep problems that impact patient safety. In a study of 635 nurses, researchers found that the odds of making or almost making a medication error doubled among those RNs that rotated shifts (Gold et al., 1992).

Finally, most nurses who work in hospitals often have to work weekend shifts. Previous researchers have found that staffing levels in acute care hospitals tend to be lower on weekends than on weekdays, which negatively influences hospital functioning (Bell & Redelmeier, 2001). A full literature review of off-shifts and the effect on quality and employee outcomes is discussed in Chapter 2.

Significance and Gaps

In hospitals, nurses must continue to work off-shifts to provide 24 hours-a-day, 7 days-a-week care to patients. It is important to understand how nurses maintain patient safety and deliver quality care on the off-shifts. To our knowledge, there is only one other research team that is qualitatively studying nursing work environments on off-shifts. Additionally, it is equally important to quantitatively examine off-shift nurse staffing and patient outcomes. However, focusing solely on nurse staffing levels on off-shifts ignores other important characteristics of the nursing workforce that can affect patient safety. There are currently no studies that simultaneously consider off-shift nurse staffing and characteristics of the nursing workforce on quality care.

There are further gaps in the state of the science. Researchers often use cross-sectional designs and aggregate hospital-level data when studying nurse staffing and patient outcomes. There are limitations to cross-sectional designs and hospital-level data. For example, researchers cannot infer causality from cross-sectional designs. Furthermore, hospital-level measurement of staffing is limited because the researcher cannot link staffing data to individual patient outcomes. To address these gaps, a four year panel, longitudinal unit-level data set was used to test

variations in nursing inputs (*i.e.*, staffing and nursing workforce variables) by shift and patient outcomes.

A mixed method approach, which is discussed in detail in Chapter 3, was used. The two aims for this dissertation are listed below.

Aims and Hypotheses

Aim 1. To qualitatively explore nurse perceptions of off-shift nursing and quality of care as compared to more regular hours.

To address this aim, qualitative methods that included observer-as-participant observations and semi-structured interviews were used. The rationale of choosing these methods and findings from this portion of the dissertation are presented in Chapter 4. Findings from Aim 1 that influenced Aim 2 and are presented in Chapter 5.

Aim 2. To quantitatively test the variations of nursing inputs (*i.e.*, staffing and human capital) during the day as compared to night on length of stay (LOS).

To address Aim 2, a secondary analysis of a four-year, longitudinal dataset was conducted. This dataset included patient and employee data from the Veterans' Affairs (VA) acute care facilities from the years 2003 through 2006. The full methods and the results from this portion of the dissertation are presented in Chapter 5.

There are three hypotheses for Aim 2:

Hypothesis 1: On acute care units, less night nurse staffing will negatively impact LOS

Hypothesis 2: On acute care units, less RN night shift education and years of prior experience will negatively impact LOS

Hypothesis 3: On acute care units, less night shift RN unit, facility, and VA tenure will negatively impact LOS

Potential Contributions

There are two major anticipated contributions to nursing science that may be gained from this dissertation project. First, better understanding of the delivery of nursing care may have an impact on policy implications when considering staffing ratios especially on off-shifts. Secondly, research from this dissertation project may assist nurse managers to simultaneously consider staffing, education, and experience level when developing appropriate off-shift staffing.

Table 1.1 National voluntary consensus standards for nursing-sensitive care	
FRAMEWORK	MEASURE
Patient-centered outcome measures	1. Death among surgical in-patients with treatable serious complications (failure-to-rescue)
	2. Pressure ulcer prevalence
	3. Falls prevalence
	4. Falls with injury
	5. Restraint prevalence (vest and limb only)
	6. Urinary catheter-associated urinary tract infection for ICU patients
	7. Central line catheter-associated blood stream infection rate for ICU and high-risk nursery (HRN) patients
	8. Ventilator-associated pneumonia for ICU and HRN patients
Nursing-centered intervention measure	9. Smoking cessation counseling for acute myocardial infarction
	10. Smoking cessation counseling for heart failure
	11. Smoking cessation counseling for pneumonia
System-centered measures	12. Skill mix (Registered nurse [RN], Licensed Vocational/Practical Nurse [LVN/LPN], unlicensed assistive personnel [UAP] and contract)
	13. Nursing care hours per patient day (RN, LPN, and UAP)
	14. Practice Environment Scale - Nursing Work Index (composite and five subscales)
	15. Voluntary turnover
National Quality Forum: A Consensus Report, 2004	

Table 1.2 Agency for Healthcare Research and Quality hospital-level PSIs	
PSI	NAME
1	Complications of anesthesia
2	Death in low mortality
3	Pressure ulcer
4	Failure-to-rescue
5	Foreign body left in during procedure
6	Iatrogenic pneumothorax
7	Selected infections due to medical care*
8	Postoperative hip fracture
9	Postoperative hemorrhage or hematoma
10	Postoperative physiologic and metabolic derangements
11	Postoperative respiratory failure
12	Postoperative pulmonary embolism or deep vein thrombosis
13	Postoperative sepsis
14	Postoperative wound dehiscence in abdominopelvic surgical patients
15	Accidental puncture and laceration
16	Transfusion reaction
17	Birth trauma - injury to neonate
18	Obstetric trauma – vaginal delivery with instrument
19	Obstetric trauma – vaginal delivery without instrument
20	Obstetric trauma – cesarean delivery
AHRQ Quality Indicators – Guide to Patient Safety Indicators, 2003	
Notes: * Recently renamed, PSI = Patient Safety Indicators	

Chapter 2: Twenty-Four / Seven: A Systematic Review of the Off-shift Literature

In this Chapter, a systematic review of the off-shift literature was conducted. The purpose of the review was to synthesize and critique the evidence on off-shifts and quality and employee outcomes. As part of the review, non-healthcare studies were initially included, but due to page limitations in the submitted work, these studies were not included in the submission process. The review of the non-healthcare outcome studies are presented in Appendix A.

Abstract

Aim. This paper is a systematic review of the evidence on “off-shifts” (nights, weekends, and/or holidays) on quality and employee outcomes in hospitals.

Background. Healthcare workers often provide 24-hour-a-day, 7-day-a-week service. Quality and employee outcomes may differ on off-shifts as compared to regular hours.

Data sources. Databases searched included Business Source Complete, ProQuest, EconLit, PubMed and MEDLINE.

Review methods. To be included in the review, the studies met the following criteria: 1) the independent variable of interest was an off-shift; 2) the article was a research study (*e.g.*, it was not an editorial); 3) the article was published in a peer-reviewed journal; 4) the article could be obtained in English; and, 5) the article pertained to healthcare. Studies were not excluded based on research design.

Results. Fifty-four studies were included. Four of the articles were qualitative. There was strong evidence that patients were more likely to die if they were admitted on weekends as compared to during the week. This was not found when patients were admitted during nighttime hours. However, there was strong evidence that babies born at night were more likely die as compared to babies born during the day. Employees who work at night and rotate to work night reported suffering from more fatigue and stress.

Conclusion. Outcomes on weekends and nighttimes are worse. It is important to further investigate why care on off-shifts is different from more regular hours.

Summary Statement

What is already known about this topic

- On off-shifts, hospitals have decreased services available as compared to during the day.
- Healthcare providers who work at night and rotate to work at night are at risk for fatigue.

What this paper adds

- Weekends are precarious times for patients.
- Employee outcomes are often worse for employees who rotate to work at night as compared to employees who work on fixed night schedules.

Implications for practice and/or policy

- There is a need to understand what specifically happens on off-shifts (*e.g.*, less staffing, less experienced employees who work these shifts, and lack of supervision) that may impact quality care.

Keywords: systematic review, nights, weekends, patient outcomes

Introduction

Healthcare providers in hospitals deliver patient care 24 hours-a-day, 7 days-a-week. To ensure patient coverage, some providers must work “off-shifts”, which include nights, weekends, and holidays. The quality of care provided on off-shifts may differ from more regular hours. This may be due to lower levels of staffing, less resources, and less supervision. Specifically for weekends, researchers have found that clinical personnel staffing levels in acute care hospitals tend to be lower on weekends than on weekdays; and, hospitals function less effectively on weekends (Bell & Redelmeier, 2001). Additionally, employees who work at night may have higher levels of fatigue than employees who work during the day. Researchers have found that shift workers rarely report getting the recommended eight hours of sleep (Axelsson, Akerstedt, Kecklund, & Lowden, 2003). Decreased levels of sleep may lead to medical errors. Work duration and number of hours worked per week also have significant effects on medical errors (Rogers et al. 2004). Additionally, working at night can impact employees’ circadian rhythm, social and family life, and overall health such as digestive and health conditions (Rosa & Colligan, 1997).

The Review

Aim

The aim of this review was to synthesize the evidence on off-shifts and quality patient care. An additional aim was to synthesize the evidence on healthcare providers who work night shift, or rotated to work night shift, and their risk for sleep disorders or decreased well being as compared to providers who worked more regular hours.

Design

A systematic review including quantitative and qualitative studies of the off-shift literature in hospitals was conducted. The review process was guided by the Centre for Reviews and Dissemination manual from York University on identifying and organizing published literature for healthcare (University of York, 2009). This manual provides systematic review methods including how to search for evidence, develop inclusion and exclusion criteria, extract data, appraise evidence, and synthesize the results. The authors also provide guidelines on how to synthesize relevant qualitative studies to help interpretation of the quantitative findings (University of York, 2009). To be comprehensive, all types of study designs were included in the review. Due to study heterogeneity, a meta-analysis could not be performed.

Search Methods

Databases searched included Business Source Complete, EconLit, ProQuest, PubMed, and MEDLINE. These multidisciplinary databases were searched to identify relevant studies that could not have been located in health-related databases. The years covered by the search included 1985 through February 2010. The justification for a 25-year search period was to identify all possible studies and to determine whether more studies on quality care were published in recent years given the 1999 Institute of Medicine Report. Key words included 'shift work', 'nights', 'weekends', 'off-peak hours', 'off-shifts', 'patient outcomes', 'productivity', and 'quality'. The reference lists of included articles were reviewed to retrieve additional studies. To be included in the review, the studies meet the following criteria: 1) the independent variable of interest was an off-shift; 2) the article was a research study (*e.g.*, it was not an editorial); 3) the article was published in a peer-reviewed journal; 4) the article could be obtained in English; and,

5) the article pertained to healthcare. The search period for studies began on August 1, 2009 and continued until February 25, 2010.

Search Outcome

The search identified 674 titles and abstracts, which were reviewed to determine eligibility. Five hundred ninety of these were excluded after reading the abstract and/or browsing text: A total of 88 full-text articles were identified as potentially eligible. Of these, 34 were further excluded because off-shifts were not clearly defined, independent and dependent variables were not pertinent to the search, the study did not pertain to healthcare, and/or lack of information. Fifty-four articles were retrieved and reviewed. Figure 2.1 displays the flow chart of the study selection process. Studies were not excluded based on the quality of the research methodology.

Quality Appraisal

An article quality assessment tool (available from authors) was adopted and used to abstract data for the quantitative studies included in this review (Aboelela, Stone, & Larson, 2007). Quantitative articles were assessed for quality of evidence by description of sample, defined outcome assessment, and statistical approach (Table 2.1 for criteria), however, due to the diversity of settings, samples, and study design, an overall score for each article was not calculated. For studies that used qualitative methods, this form was not used. Qualitative findings were described in narrative form.

Data Abstraction and Synthesis

Data were abstracted by the first author (PdC) and all abstracted data were reviewed by and discussed with the senior author (PWS). The following data were abstracted: setting, sample, study design, definition of off-shift studied (*e.g.*, nights, nights and rotation, weekends, holidays, and/or combination), conceptualization and operationalization of outcome(s) for quantitative studies, and key findings. Data synthesis included examining relationships between how researchers defined off-shifts and what type of outcomes were studied. The studies were first divided by type of outcome and/or finding (*e.g.*, patient or employee). Patient outcome studies were further grouped by specific independent variables (*e.g.*, time of admission/discharge, time of birth, time of procedures, and nurse staffing). For all quantitative studies, the association between off-shifts and poor patient and/or employee outcomes are presented. Full evidence tables are available from the authors.

Results

Table 2.2 presents the characteristics of the 54 studies. A slight majority, (52%, $n = 28$) of the studies were from North America. The diversity of countries represented in this review reflected the international importance of examining the quality care on off-shifts. In the studies, researchers utilized case-control, cross-sectional, longitudinal, interventional, and qualitative designs. No randomized controlled trials were identified. Researchers most often used longitudinal study designs (65%, $n = 35$). Both case-control and interventional designs were rare. Four research teams used qualitative methods. Approximately half of studies were multisite. The majority, (66%, $n = 33$) pertained to patient quality and the remainder of the studies pertained to the employees.

Definition of Off-shifts

All of the researchers identified whether an off-shift occurred at night, and/or on the weekend. off-shifts were also defined as “after hours”, “off-hours”, “non-office hours” and “off-peak hours.” There was inconsistency in both terminology and definitions. For example, in one study “nights” began at 1800, and in another study, “nights” began at 1701 (Morales, Peters, & Afessa, 2003; Pilcher, Duke, George, Bailey, & Hart, 2007). Although researchers consistently defined “weekends” as Saturday and Sunday, they disagreed on the exact time when the weekend began. In the quality outcome studies, the exact times of the off-shift were often provided. Conversely, employee outcome or qualitative methods did not clearly define the exact time of the off-shift.

Quality Outcomes Studies

There were 33 studies that examined patient quality outcomes. These outcomes included mortality, length of stay, frequency of procedures, and treatment delays. Nineteen studies examined the association between time of admission and/or discharge and patient outcomes. Seven groups of researchers studied the time of birth as the independent variable. Five studies examined the time of procedures and patient complications on off-shifts and two studies examined the association between nighttime nurse staffing and outcomes.

Relationship between time of admission and/or discharge and quality outcomes.

The majority (89%, n = 17) of researchers examining relationships between time of admission and/or discharge and quality outcomes focused on weekends as the off-shift variable (Table 2.3). Although the hospital settings varied, 63% of the researchers examined patients in intensive care units (ICUs). In addition to patients admitted, there were 3 studies that examined patients

discharged from ICUs. The sample sizes in these studies ranged from 611 – 3,789,917 patients. There was also a variety of patient populations studied. A majority (89%, n = 17) of the researchers sampled adult patients, yet medical specialty differed including stroke, (Saposnik, Baibergenova, Bayer, & Hachinski, 2007) cardiac, (Kostis et al., 2007) and burn patients (Taira, Meng, Goodman, & Singer, 2009). Two studies sampled neonates and/or children (Hixson, Davis, Morris, & Harrison, 2006). Only five studies occurred in a single site (Arabi, Alshimemeri, & Taher, 2006; Barba et al. 2006; Hixson et al. 2005; Morales et al. 2003; Sheu et al. 2007).

In these 19 studies, all of the researchers examined mortality as one of the outcomes. Most of the researchers (84%, n = 16) defined mortality as in-hospital mortality. However, other definitions of mortality were used. For example, Saposnik et al. (2007) sampled stroke patients and defined mortality as death 7-day from stroke onset whether it occurred in the hospital or not. A strength of many these studies is the use of multivariate logistic regression controlling for the following confounders: age, sex, severity of illness, medical complications, and treatment facility.

In the eight studies that defined off-shifts as weekend-only, the results were mostly consistent and researchers found that patients were more likely to die if they were admitted on weekends as compared to during the week (Barba et al., 2006; Barnett, Kaboli, Sirio, & Rosenthal, 2002; Bell & Redelmeier, 2001; Cram, Hillis, Barnett, & Rosenthal, 2004; Ensminger et al. 2004; Kostis et al. 2007; Saposnik et al. 2007; Schilling, Campbell, Englesbe, & Davis, 2010). Ensminger et al. (2004) found that patients admitted to a surgical ICU on weekends were more likely to die; this effect was not found for medical ICU patients. The results were also mixed when off-shifts was defined as nights exclusively; one group of researchers found that

patients were more likely to die if they were admitted at night (Pilcher et al., 2007) and the other did not find this effect (Morales et al., 2003).

In the nine studies in which researchers examined nights *and* weekends, both the methods of analyses and the results varied. Among these studies, 44% (n = 4) of researchers analyzed nights and weekends together, another 44% (n = 4) analyzed them separately, and one group performed their analyses together and separately. When nights and weekends were analyzed together, researchers did not find that patients who were admitted on off-shifts had higher mortality (Abdel-Latif, Bajuk, Oei, & Lui, 2006; Luyt et al., 2007; Sheu et al., 2007; Taira et al. 2009). These results were also similar for two of the studies that analyzed nights and weekends separately, that is, in these two studies neither nights nor weekends were associated with mortality. (Arabi et al., 2006; Hixson et al., 2005).

In this group of nineteen studies, patient length of stay was also conceptualized as a quality outcome in six studies (Arabi et al., 2006; Barnett et al., 2002; Kostis et al., 2007; Morales et al., 2003; Sheu et al., 2007; Taira et al., 2009). The setting in four of these six studies was an ICU (Arabi et al., 2006; Barnett et al., 2002; Morales et al., 2003; Sheu et al., 2007) and in only one study was there a statistically significant difference in intensive care length of stay for weekend or Friday admissions compared with midweek admissions (Barnett et al., 2002). However, the study by Barnett et al. was multi-site and the other three studies occurred in a single setting and had smaller sample sizes. Therefore, statistical power may have been an issue.

Relationship between time of birth and quality outcomes. Seven research teams examined the association between time of birth and neonatal outcomes (Table 2.4). A majority (85%, n = 6) of the researchers studied outcomes of those babies born at night compared to days

(Badr, Abdallah, Balian, Tamin, & Hawari, 2007; Caughey et al., 2008; Gould, Qin, & Chavez, 2005; Luo & Karlberg 2001; Stewart, Andrews, & Cartlidge, 1998; Urato, Craigo, Chelmow, & O'Brien 2006). The sample sizes in these studies ranged from 1,015 to over 3 million babies. One study used a case-control design, whereas the other studies were longitudinal. Most researchers used database registries (Gould et al., 2005; Luo & Karlberg 2001; Stephansson, Dickman, Johansson, Kieler, & Cnattingius, 2003; Stewart et al., 1998; Urato et al., 2006). Only one study was multisite (Badr et al., 2007). Similar to articles examining time of admission, infant mortality was the quality outcome in all studies, but other neonatal outcomes were also considered. All of the researchers used logistic regression and controlled for confounders, which included maternal age, birth weight, prenatal care, number of pregnancies, race, and delivery by midwife.

In only one study researchers did not find an association between time of birth and mortality. In this study, Caughey et al. (2008) compared neonatal outcomes by three time periods – day, evening, and night. All of the other results were mostly consistent and the researchers found that babies born at night were more likely to die than those born during the day (Badr et al., 2007; Gould et al., 2005; Luo & Karlberg 2001; Stephansson et al., 2003; Stewart et al. 1998; Urato et al., 2006).

Relationship between time of procedures and patient complications on off-shifts.

Five groups of researchers were interested in determining if patients were delayed treatment or developed complications on off-shifts (Table 2.5). Authors provided clear definitions of the off-shift they intended to study and the sample sizes were large ranging from over 1,000 to almost 5 million patients. Two groups of researchers used database registries (Becker 2007; Bendavid, Kaganova, Needleman, Gruenberg, & Weissman, 2007). Cardiac patients were sampled in four

of the five studies (Becker 2007; Peberdy et al., 2008; Sadeghi et al., 2004; Uyarel et al., 2009). The other group examined complication rates of eight patient safety indicators including postoperative hemorrhage, newborn trauma, vaginal deliveries, and obstetric trauma during cesarean sections (Bendavid et al. 2007). Out of the five groups, three found that patients were more likely to have delays in treatment and/or develop complications on off-shifts as compared to more regular hours (Becker 2007; Bendavid et al., 2007; Peberdy et al., 2008).

Night nurse staffing and quality outcomes. There were two studies that examined the association of night nurse staffing and hospital mortality (Table 2.6). Secondary outcomes included patient length of stay and total hospital cost (Amaravadi et al., 2000; Dimick et al., 2001). These researchers studied the effect on patient outcomes when night nurses cared for 1 or 2 patients as compared to 3 or more patients in ICUs (Amaravadi et al., 2000; Dimick et al., 2001). In both studies, the researchers found no significant difference in patient mortality, but did find that hospital length of stay and cost increased when night nurse-to-patient ratio was greater than 1:2 (Amaravadi et al., 2000; Dimick et al., 2001).

Employee Outcomes Studies

There were 17 studies that examined employee outcomes (Table 2.7). Off-shift was defined as nights in ($n = 7$) or nights with rotation ($n = 10$). In the studies where researchers focused on nights, a variety of healthcare workers were sampled. One group of researchers studied nurses as well as their significant others (Newey & Hood, 2004). The sample sizes for these seven studies ranged from 38 to 7,717 participants. Most ($n = 5$) used cross-sectional designs. In the study with the largest sample, researchers longitudinally examined 7,717 workers' compensation claims in Oregon and found that nurses who worked at night had more

injuries (Horwitz & McCall, 2004). Only two studies occurred in a single setting (Arora et al. 2006; West, Ahern, Brynes, & Kwanten, 2007).

Ten groups of researchers examined the association between nights with rotation with and multiple employee outcomes (Admi, Tzischinsky, Epstein, Herer, & Lavie, 2008; Barton, 1994; Burch, Tom, Criswell, Leo, & Ogooussan, 2009; Choobineh, Rajaeefard, Neghab, 2006; Geiger-Brown, Muntaner, Lipscomb, & Trinkoff, 2004; Gold et al., 1992; Jamal & Baba 1992; Korompeli, Sourtzi, Tzavara, & Velonakis, 2009; Leff et al., 2008; Samaha, Lal, Samaha, & Wyndham, 2007). Similar to the “night-only” studies, researchers sampled a variety of healthcare workers. However, the sample sizes were generally smaller (range 21 - 635) than those in the night studies. Most investigations were cross-sectional, however one group also used an interventional strategy to evaluate surgical skills after a resident rotates to night shift (Leff et al., 2008). Half of these studies were multisite.

Fatigue and sleep disturbances. In both the nights and nights with rotation studies, most groups of researchers (n = 12) examined fatigue and sleep disturbances as an outcome (Admi et al., 2008; Arora et al., 2006; Barton 1994; Burch et al. 2009; Choobineh et al., 2006; Gold et al., 1992; Korompeli et al., 2009; Leff et al., 2008; Newey & Hood 2004; Ruggiero 2003; Samaha et al., 2007; West et al., 2007). Ruggiero (2003) found that providers that worked at night had less quality sleep than those who worked during the day. Arora et al. (2006) tested a sleep intervention and found a significant effect that sleep efficiency improved when an intern napped. Four groups of researchers found statistically significant associations between night rotation and poor sleep (Choobineh et al. 2006; Gold et al. 1992; Korompeli et al. 2009; Leff et al. 2008). Additionally, one researcher found that nurses and midwives had significantly more

sleep difficulties when they rotated to work at night than did permanent night shift nurses (Barton, 1994).

Mental well being. Some of these researchers ($n = 6$) also examined psychological outcomes such as mental well-being (Barnes-Farrell et al., 2008; Geiger-Brown et al., 2004; Horwitz & McCall 2004; Newey & Hood 2004; Peterson, 1985; Ruggiero, 2003). These groups found significant associations between night work and lower mental well-being. Specifically, Ruggiero et al. (2003) found that permanent night nurses had significantly more depression than did permanent day nurses. This relationship was also tested in 539 nursing assistants (Geiger-Brown et al. 2004). This team found that nursing assistants who rotated to work at night as well as work greater than 50 hours a week were more likely to meet the criteria for a depressive disorder (Geiger-Brown et al. 2004).

Job satisfaction. Job satisfaction was also examined in six studies with mixed results (Barton, 1994; Choobineh et al., 2006; Jamal & Baba 1992; Korompeli et al., 2009; Peterson, 1985; West et al., 2007). For example, one researcher found that the shift on which a nurse usually worked was not associated with poor outcomes (*i.e.*, tension or job dissatisfaction) (Peterson 1985). Korompeli et al. (2009) did find an association between night work and poor job satisfaction; however only 32 nurses were studied. Barton et al. (1994) reported that permanent night nurses preferred to work at night rather than rotating to work at night. The permanent nature of shift allowed for domestic responsibilities and provided financial incentives (Barton 1994).

Errors. Three groups examined clinical errors as an employee outcome (Admi et al., 2008; Gold et al., 1992; Leff et al., 2008). Two of the three teams found statistically significant

associations between employees who worked nights and rotated and the error rate (Gold et al., 1992; Leff et al., 2008). For example, Leff et al. (2008) found that residents who rotated took significantly longer ($p = 0.002$) and made more errors ($p = 0.025$) on a surgical simulator task following their first night shift compared with their pre-nights baseline performance.

Additionally, Gold et al. (1992) found that nurses who rotated were almost two times more likely to report an accident and/or errors compared to nurses who worked day and/or evenings (OR 1.97, 95% CI 1.07 - 3.63).

Qualitative Method Studies

Four groups of researchers used qualitative methods to understand off-shift nursing work. These researchers inductively examined nurses' perceptions about quality outcomes (*e.g.*, neonatal mortality) and employee outcomes (*e.g.*, fatigue). Different qualitative data collection methods were used including open-ended interviews, semi-structured interviews, and focus groups. The purposeful sampling procedures were described in all studies. Three groups of researchers explored nurses' perceptions of working at night (Campbell, Nilsson, & Andersson 2007; Nasrabadi, Seif, Latifi, Rasoolzadeh, & Emami, 2009; Nilsson, Campbell, & Andersson 2008). The other group's aim was to identify differences between weekend and weekday nurse work environments in the labor and delivery department (Hamilton, Eschiti, Hernandez, & Neill 2007).

In two of the four studies, themes of decreased staff on off-shifts emerged. Nilsson et al. (2008) found that night work assignments were similar to those in the daytime, but are carried out by fewer staff. Hamilton et al. (2007) found that the reduced number of clinicians, supervisors, and patients made it possible to provide better care, while others felt there were

serious lapses in patient safety. The other two studies found nighttime was an opportunity to learn and gain more experience (Campbell et al., 2007; Nasrabadi et al., 2009). Both groups found there were learning situations at night; additionally, night nurses sometimes demonstrated more independent thinking due to decreased resources available. (Campbell et al., 2007; Nasrabadi et al., 2009).

Discussion

Hospitals will continue to function 24-hour-a-day, 7-day-a week. Therefore, it is important to understand if in the current organization of the healthcare system off-shifts are associated with poor patient and employee outcomes. To the best of the authors' knowledge, this is the first systematic review examining relationships between off-shifts and outcomes. In this review we attempted to be comprehensive and did not exclude studies based on research design. While the findings were mixed, weekends were associated with poor quality patient outcomes. At night, there was minimal evidence that quality outcomes suffered, except in the labor and delivery room. When nights and weekends were analyzed together, the evidence was also mixed. Since weekends were associated with poor patient outcomes, it is possible that grouping nights and weekends together may mask the negative effect of the weekend.

In the employee outcomes studies, there was strong evidence that providers who work at night and rotate to work at night were more likely to have poor outcomes (*e.g.*, fatigue, decreased mental well being, and job dissatisfaction). However, from this review, it cannot be determined if those poor employee outcomes impacted quality care. There were only three studies that evaluated errors in addition to employee outcomes, and the results from those studies were mixed. We found that some employees preferred night shifts, therefore, managerial implications

include determining what shift an employee prefers to work. Because the evidence points to sleep disturbances when working rotating shifts, managers should look for employees that will permanently work at night.

While the quantitative studies examined associations between off-shifts and outcomes, the qualitative studies explored why these outcomes may have occurred. This provided a greater understanding of the mechanisms that may contribute to the poor quality. In these studies, the participants described a lack of resources and supervision on the off-shifts, which may be the reason for the poor outcomes. However, there were also benefits of working at night, which included opportunities to learn.

Limitations and Strengths of the Evidence

Employee outcome studies had generally smaller sample sizes than the quality outcome studies. In these studies, researchers often used cross-sectional designs based on self-report. The results from these studies were mixed. For example, some employees reported fatigue and some did not. An employee may not report fatigue if she/he has adapted to working at night. Additionally, some employees may experience fatigue, but chose to work at night for personal reasons. Having control over one's schedule may contribute to why researchers found higher rates of fatigue, but did not find any differences in attitude or job satisfaction at night as compared to during the day (West et al., 2007).

The majority of the studies examining quality outcomes were longitudinal; which is a stronger research design than the cross-sectional studies. However, there were also weaknesses in the investigations studying patient outcomes. For example, the researchers often used administrative databases, which have inherent limitations. First, although the majority of

researchers implemented quality control measures for data abstraction, there may have been errors in this process and/or the data may be incorrectly coded in the database. Additionally using existing databases for analysis, there may be unmeasured confounders.

Another limitation of the quality outcome studies is that they were limited in studying the relationship between time of admission/discharge and mortality. Admission and discharge time may be the easiest to operationalize in large databases. However, this does not inform the processes of care. Researchers often acknowledged this limitation, and commented that staffing levels or decreased resources on off-shifts may be factors that impact quality care. A comprehensive examination staffing and characteristics of the off-shift staff compared to regular hours may further assist in understanding quality on off-shifts.

Patient mortality was the most common quality outcome studied. This is not surprising since mortality is clearly important as well as easily identified in the datasets. It is also a common measure of quality care and has been endorsed by the National Quality Forum (NQF, 2004). Patient length of stay in the hospital was infrequently examined; however, some studies examined intensive care length of stay. In only five studies identified rates of procedures and complications on the off-shifts were examined. This was surprising given the increased international interest in patient safety and nursing sensitive outcomes (Clarke & Aiken 2008; Chaboyer, Johnson, Hardy, Gehrke, & Panuwatwanich, 2010). We encourage future researchers to study these other important quality outcomes.

Although the majority of studies that compared quality of care provided on weekends to mid-week found outcomes to be less desirable on the weekends, the overall results of off-shifts and quality outcomes were mixed. An explanation may be from the diversity of patient

populations. Although known confounders were often controlled for, underlying patient differences may have contributed to the mixed results. Also, many studies in which researchers did not find an association between off-shifts and quality outcomes occurred in a single institution. In these single-site studies, a hospital may have similar staffing and/or education level of healthcare providers and/or continuous on-site coverage by qualified intensivists on both regular and off-shifts or sample sizes and a lack of statistical power may have contributed to the lack of differences. Overall, multi-site studies were stronger in design and increased the generalizability of results.

There was inconsistency on how off-shifts were defined. For example, researchers defined weekend admission as one occurring between Wednesday 6:00 PM to Saturday 7:59 AM in one study and Saturday midnight to Sunday 11:59 PM in another study (Arabi et al., 2006, Laupland et al., 2008). This variation of definitions may be contributed to regional differences on what days constituted a work week. Thus, defining the exact “hour” that constituted an off-shift could not easily be done. There were other differences in how researchers grouped and analyzed the off-shifts. For example, some researchers who studied both nights and weekends, conducted their analyses together, as opposed to performing separate analyses of nights and separate analyses of weekends. Again, this posed challenges when synthesizing the results.

Limitations and Strengths of the Review

There are strengths and limitations to this review. Although we attempted to be comprehensive and a thorough search of the literature was conducted over several months, it is possible that some studies were missed. Publication bias may be present; however, we did find studies that found no differences diminishing our concern about this potential bias. Due to

limited resources, only studies that were in English were included in the review. Quality of studies were assessed, however there were inconsistencies of definitions, study designs, and outcomes. There was no attempt to numerically grade the studies level of evidence; however evidence based tables with all abstracted data are available from the authors.

Conclusion

The overall conclusion of this systematic review is that a slight majority of the researchers found that off-shifts may be associated with poor patient and employee outcomes. Specifically, patients admitted to hospitals on weekends are more likely to die and not receive necessary procedures. This effect was not found for patients admitted at night. Contrarily, babies who were born at night were more likely to die. Employees who do work at night are more likely to suffer from fatigue as compared to employees who work during the day. Furthermore, when employees rotate to cover night shifts, they are also more likely to suffer from fatigue. However, there is minimal evidence that poor employee outcomes may negatively impact quality care. Differences in the evidence exist between nights and weekends, future research should examine these types of off-shifts more closely.

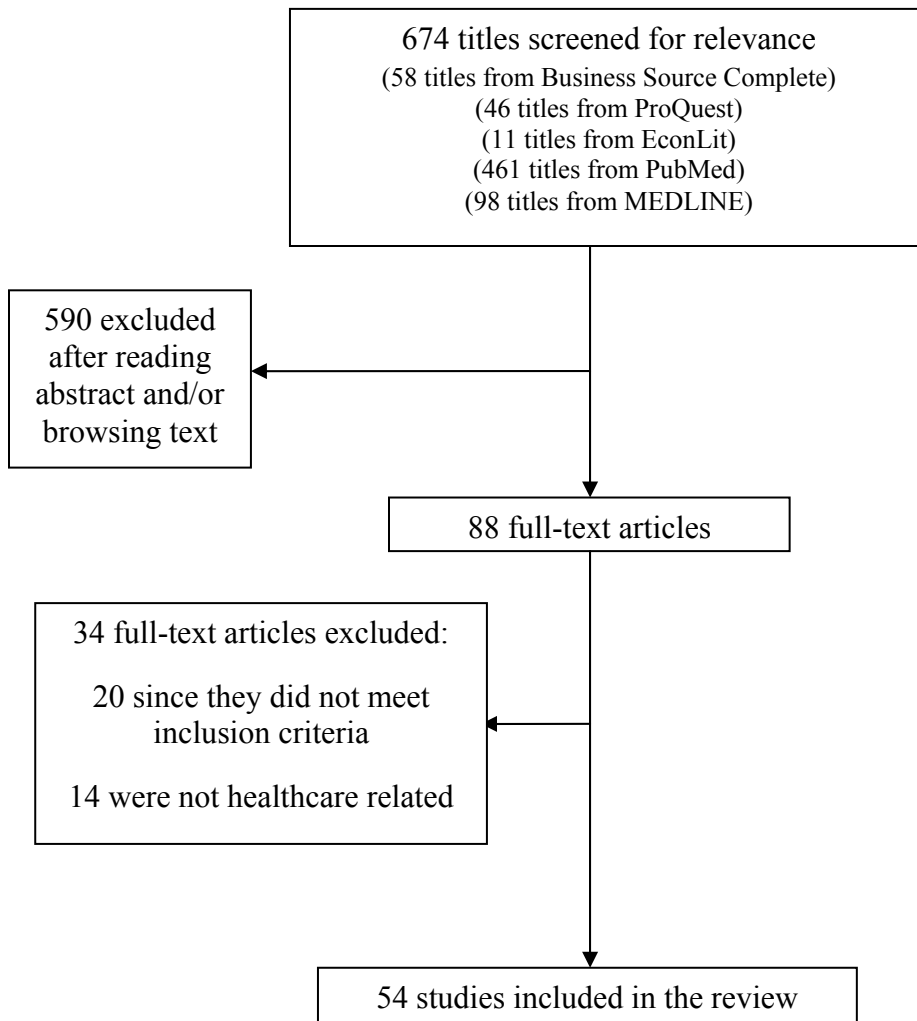


Figure 2.1: Study selection process

Table 2.1. Quality assessment criteria	
Article Identification	First author, date of review
Setting, Sample, Study Design	<p>What is the country of origin?</p> <p>What is the occupation being studied?</p> <p>What is the setting of the study?</p> <p>How many subjects were included?</p> <p>What was the study design?</p> <p>Which of the following did the outcomes pertain to (<i>e.g.</i>, patient or employee)?</p> <p>What was the unit of analysis?</p>
Representativeness of Study Population	<p>Were detailed inclusion/exclusion criteria provided?</p> <p>How well did the study population represent the larger population?</p>
Independent Variables and Outcomes	<p>Were definitions of off-shifts provided?</p> <p>What were those definitions?</p> <p>How clearly defined were the outcome assessment procedures?</p> <p>How was the outcome(s) measured?</p>
Statistical Quality	Were the methods of statistical analysis properly described?
Key Results/Findings	<p>What were the results/findings?</p> <p>Did the discussion section reflect the results of the study?</p>

Table 2.2. Characteristics of studies in the systematic review

			n = 54
			n (%)
Geographic location:			
	North America		28 (52)
	Europe		13 (24)
	Asia/Middle East		6 (11)
	Australia and New Zealand		4 (7)
	Multinational		3 (6)
Design:			
	Case-Control		1 (2)
	Cross-sectional		13 (24)
	Longitudinal		35 (65)
	Interventional		1 (2)
	Qualitative methods		4 (7)
Multisite*:			
	Yes		29 (58)
	No		13 (26)
	Database registries		8 (16)
Definition of Off-shifts**:			
	Nights		29 (48)
	Nights with rotation		9 (15)
	Weekends		19 (31)
	Off-shifts (nights, weekends, holidays not distinguished)		4 (7)
Outcomes*:			
	Quality		33 (66)
	Employee		17 (34)
Notes: *The 4 studies using qualitative methods were not included in this category **These categories were not mutually exclusive			

Table 2.3 Studies examining time of admission and/or discharge and patient outcomes

Author(s) & Year	Definition of off-shift	Setting	Sample size	Multisite (# of sites)	Outcome(s)	Increased risk for poor quality outcomes
Nights						
Pilcher et al. 2007	“After hours” 1800 to 0559	ICUs	84,928	Y (40)	Mortality & ICU readmission rate	Y
Morales et al. 2003	Night: 1701 to 0659	ICU	6,034	N	Mortality, ICU LOS	N
Weekends						
Schilling et al. 2010 ^a	Saturday and Sunday	Hospitals	166,920	Y (39)	Mortality	Y
Saposnik et al. 2007	0000 Saturday to 2259 Sunday	Hospital Morbidity Database	26,676	Y (606)	7-day mortality from stroke	Y
Kostis et al. 2007	Saturday and Sunday	Myocardial Infarction Data System	231,164	Y (all New Jersey hospitals)	30-day mortality from myocardial infarction, LOS, use of invasive cardiac procedures	Y
Barba et al. 2006	0000 Saturday to 2259 Sunday	Hospital	359,993	N	Mortality (within 48 hours)	Y
Cram et al. 2004 ^b	0000 Saturday to 2259 Sunday	Acute care hospitals	641,860	Y (all California hospitals)	Mortality	Y
Ensminger et al. 2004	1700 Friday to 0700 Monday	ICUs	29,084	Y (2)	Mortality	Mixed
Barnett et al. 2002	0001 Saturday to 0001 Monday	ICUs	156,136	Y (28)	Mortality, ICU LOS	Y
Bell & Redelmeier 2001	0001 Saturday to 0001 Monday	Acute care hospitals	3,789,917	Y (all Ontario hospitals)	Mortality	Y

Nights and weekends									
Taira et al. 2009 ^c	“Off-hours” 1800 to 0600	Trauma	25,572	Y (700)	Mortality & LOS	N			
Laupland et al. 2008 ^d	Night: 1800 to 0559 Weekend: 0001 Saturday to 2259 Sunday	ICUs	20,446	Y (4)	Mortality	Mixed			
Sheu et al. 2007 ^c	“Non-office hours” 1800 to 0800 on weekday and all times on weekends	ICU	611	N	Mortality, LOS, ventilator-free days	N			
Luyt et al. 2007 ^c	“Off-hours” 1830 to 0829 Weekend: 1300 Saturday to 0829 Monday and Holidays: 0830 to 0829 following day	ICUs	51,643	Y (23)	Mortality	N			
Abdel-Latif et al. 2006 ^c	“After hours” including holidays 1801 to 0759	Neonatal ICUs	8,654	Y (10)	Mortality within 7 days & major morbidity of infants < 32 weeks	N			
Arabi et al. 2006 ^d	Night: 1800 Saturday to 0759 Tuesday Weekend: 1800 Wednesday to 0759 Saturday	ICU	2,093	N	Mortality, ICU LOS, ventilator-free days	N			
Hixson et al. 2005 ^d	Evening: 1900 to 0700 Weekend: Saturday and Sunday	Pediatric ICU	5,968	N	Mortality	N			
Wunsch et al. 2004 ^d	Evening: 1800 to 2359 Night: 0000 to 0759 Weekend: Saturday and Sunday	ICUs	56,250	Y (102)	Mortality	Mixed			
Uusaro et al. 2003 ^{c,d}	“Out of office hours” 1601 to 0759 Weekend: 1600 Friday to 2359 Sunday	ICU	23,134	Y (18)	Mortality	Mixed			

Table 2.4. Studies examining the association between time of birth on patient outcomes						
Author(s) & Year	Definition of off-shift	Sample size	Multisite (# of sites)	Outcome(s)	Increased risk for poor quality outcomes	
Nights						
Caughey et al. 2008	Evening: 1800 to 0000 Night: 0001 to 07000	34,046	N	Mortality, apgar scores	N	
Badr et al. 2007	Night: 2300 to 0700	5,152	Y (4)	Mortality, asphyxia, morbidity	Y	
Urato et al. 2006	Night: 2301 to 0759	80 cases, 999 controls	Registry	Mortality	Y	
Gould et al. 2005	Early night: 1900 to 0059 Late night: 0100 to 0659	3,363,157	Registry	Mortality	Y	
Luo & Karlberg 2001	Night: 2100 to 0700	2,102,324	Registry	Mortality	Y	
Stewart et al. 1998	Night: 2100 to 0859	1,015	Registry	Mortality	Y	
Nights and weekends						
Stephansson et al. 2003 ^a	Night: 2000 to 0759 Weekend: Saturday and Sunday	694,888	Registry	Mortality	Y	
Notes: Y = Yes, N = No						
^a Analyzed nights and weekends separately						

Table 2.5. Studies examining time of procedures and patient complications on off-shifts

Author(s) & Year	Definition of off-shift	Sample size	Multisite (# of sites)	Outcome(s)	Increased risk for poor quality outcomes
Uyarel et al. 2009	Night: 1800 to 0800	2,644	N	Angioplasty outcomes, cardiovascular mortality, LOS	N
Peberdy et al. 2008 ^a	Night: 2200 to 0659 Weekend: 2200 Friday to 0659 Monday	86,748	Y (507)	Survival from in-hospital cardiac arrest	Y
Becker 2007	Weekend: Saturday and Sunday	922,074	Registry	Angioplasty, cardiac catheterization, bypass rates, mortality	Y
Bendavid et al. 2007	Weekend: Saturday and Sunday	4,967,114	Registry	Complications, birth trauma	Y
Sadeghi et al. 2004 ^b	“Off-peak hours” 2000 to 0800	1,047	Y (76)	Treatment delays, thrombolysis, mortality	N

Notes: Y = Yes, N = No, LOS = Length of Stay
^a Analyzed nights and weekends separately and together
^b Analyzed nights and weekends together

Table 2.6. Studies examining nurse staffing and patient outcomes on off-shifts						
Author(s) & Year	Definition of off-shift	Sample Size	Multisite (# of sites)	Outcome(s)	Increased risk for poor quality outcomes	
Dimick et al. 2001	Night	569	Y (25)	Mortality and morbidity, LOS, total hospital cost	Mixed	
Amaravadi et al. 2000	Night	86,748	Y (23)	Mortality, LOS, total hospital cost	Mixed	
Notes: Y = Yes, N = No, LOS = Length of Stay						

Table 2.7. Studies examining off-shifts and healthcare employee outcomes

Author(s) & Year	Sample	Sample size	Multisite (# of sites)	Outcome(s)	Increased risk for poor employee outcomes
Nights					
Barnes-Farrell et al. 2008	All workers	1,014	Y ^a	Work-family conflict, physical and mental well-being	Y
West et al. 2007	Nurses	150	N	Chronic fatigue, sleep disturbances, social and domestic stressors, job dissatisfaction, burnout	Mixed
Arora et al. 2006	Medical Residents	38	N	Fatigue, on-call sleep, post-call fatigue	Y
Newey & Hood 2004	Nurses and their partners	59	Y (2)	Fatigue, health, stress, social factors	Mixed
Horwitz & McCall 2004	All workers	7,717	Registry	Injury	Y
Ruggiero 2003	Nurses	142	Y ^b	Chronic fatigue, sleep quality, depression, anxiety	Y
Peterson 1985	Nurses	272	Y (30)	Physician/nurse relations, role integration, group tension, job dissatisfaction	N
Nights with rotation					
Burch et al. 2009	All workers	376	N	Sleep characteristics, attitude, health symptoms, coping strategies, social and lifestyle factors	Mixed
Korompeli et al. 2009	Nurses	32	N	Sleep, health, coping, circadian type, job satisfaction, anxiety, personality inventory, social and domestic factors	Y
Admi et al. 2008	Nurses	738	N	Sleep disorders, medical complaints, clinical errors and adverse incidents	N
Leff et al. 2008	Medical Residents	21	N	Sleep, surgical skill performance, clinical errors	Y
Samaha et al. 2007	Nurses	121	Y (3)	Fatigue, anxiety, mood	Mixed
Choobineh et al. 2006	All workers	432	Y (12)	Insomnia, hypnotic drug use, adverse effects on own, family, and social life, health, job satisfaction	Y

Geiger-Brown et al. 2004	Nursing Assistants	539	Y (49)	Depression	Y
Barton 1994	Nurses	587	Y (28)	Fatigue, sleep disturbances, health anxiety, job satisfaction, social, domestic, nondomestic disruption	N
Jamal & Baba 1992	Nurses	585	Y (8)	Role ambiguity, role overload, job stress and satisfaction, organizational commitment, social support, turnover intention, commitment to nursing	Y
Gold et al. 1992	Nurses	635	N	Fatigue, sleep quality, medications and alcohol for sleep, medication errors, medication near misses, car accidents	Y
Notes: Y = Yes, N = No					
^a Convenience sample of healthcare workers from four countries; USA, Australia, Croatia and Brazil					
^b Random sample of 68,000 members of the American Association of Critical Care Nurses					
All study designs were cross-sectional except for Arora, Horwitz & McCall, and Leff;					

Chapter 3: Mixed Methods

This brief chapter discusses the rationale for using mixed methods in this dissertation. In this chapter, Morse and Niehaus' methodology is discussed about how to conduct a mixed methods study. Following this methodology, the qualitative portion of the dissertation is referred to as the QUAL core and the quantitative portion is the *quan* supplement. In this chapter, the theory of human capital that guided the development of the interview guide and the quantitative portion of dissertation is discussed.

Introduction

This purpose of this chapter is to present the rationale for using a mixed method approach. The methods involved in this approach allowed us to qualitatively understand the delivery of nursing care on off-shifts and also to quantitatively test variations in nursing inputs (*i.e.*, staffing and human capital) on night shift as compared to day shift. For convenience of the reader, the two aims of the dissertation are repeated below.

Aim 1. To qualitatively explore nurse perceptions of off-shift nursing and quality of care as compared to more regular hours.

To address Aim 1, qualitative methods were used that included observer-as-participant observations and semi-structured interviews.

Aim 2. To quantitatively test the variations of nursing inputs (*i.e.*, staffing and human capital) during the day as compared to night on length of stay (LOS).

To address Aim 2, a secondary analysis of a four-year, longitudinal dataset was conducted. This dataset included patient and employee data from the Veterans' Affairs (VA) acute care facilities from the years 2003 through 2006.

Mixed Methods Approach

The mixed method approach was chosen for this dissertation for two reasons; 1) to strengthen the study design, and 2) to develop multiple research skills. A mixed method design is a stronger design than one that uses a single method because it can enhance the validity of the project by enriching or expanding understanding or by verifying results from another perspective

(Morse & Niehaus, 2009, p. 14). By using both a qualitative and a quantitative piece, the findings from the qualitative section may be used to inform the quantitative analyses.

There are also debates regarding the use of mixed methods in research. Mixed methods often take more time and there are more opportunities to “muddle” the methods. A mixed method study is almost twice the work of a single method study (Morse & Niehaus, 2009, p. 21). However, the additional information obtained from the supplemental quantitative component gives this mixed method project an edge over a single method design (Morse & Niehaus, 2009, p. 90). The researchers have to be comfortable using multiple data collection and/or analysis strategies, and have the wisdom to see the relevance, pertinence, and essential need of these strategies (Morse & Niehaus, 2009, p. 21).

Using a mixed method approach does not necessarily mean that there is a qualitative section and a quantitative section. A mixed method approach can include two different qualitative methods. The major difficulty in conducting mixed method research, however, occurs when the two methodological components are drawn from different paradigms (Morse & Niehaus, 2009, p. 41). When both qualitative and quantitative components are combined in a single project, the researcher needs to consider each component thoroughly if rigor is to be maintained (Morse & Niehaus, 2009, p. 19).

To conduct the mixed method dissertation, the methodology of Janice M. Morse and Linda Niehaus was followed strictly (Morse & Niehaus, 2009). According to Morse and Niehaus (2009), four steps are necessary to conceptualize for a mixed method design. These include the following: 1) Identifying the theoretical drive, 2) Selecting the core and supplemental component, 3) Selecting the pacing of the project, and 4) Identifying the point of interface of the

core and the supplemental components. The four steps are outlined in Table 3.1. The application of each of these steps is discussed below.

The first step was to identify the theoretical drive in terms of inductive or deductive reasoning. While both types of reasoning were used in this dissertation, the main theoretical drive was inductive reasoning. Induction is generally descriptive, and activities such as naming a phenomena and positing relationships occur (Morse & Field, 2002, p. 7). This type of reasoning often begins with observations. From those observations, a researcher may be able to make generalizations, which may lead (or inform) a phenomena, paradigm or a theory. If the overall purpose of the research is to explore and to describe some phenomena, the research is inductive (Morse & Niehaus, 2009, p. 24). Overall, the theoretical drive of this dissertation was inductive because I first gained an understanding between off-shift and regular shift nurse staffing. To do this, participant observations and semi-structured interviews were conducted. Additionally, the framework of the quantitative analyses rested conceptually on the observations and the interviews indicating an inductive drive (Morse & Niehaus, 2009, p. 52).

The second step was to identify the core and supplemental component. The overall theoretical drive always dictates the method used in the core regardless of the strategies used in the supplemental component (Morse & Niehaus, 2009, p. 43). The core component is always dominant in a mixed method study; it must be conducted at a standard of rigor such that, if all else were to fail, it could be published alone (Morse & Niehaus, 2009, p. 23). As previously mentioned, the qualitative component was the core component and the quantitative component was the supplement.

The third step was to select the pacing of the project. Pacing refers to the mode in which the core and supplementary component are synchronized (Morse & Niehaus, 2009, p. 157). Pacing of the components is not a temporal assignment, but an assignment according to the conceptual contribution of each component (Morse & Niehaus, 2009, p. 105). The pacing of this dissertation was sequential in which the qualitative core component occurred first and was followed by a quantitative supplemental component. The decision to pace sequentially was deliberate because the qualitative data was used to inform the quantitative analyses. Finally, the pacing of the dissertation needed to be sequential since different samples were used.

Morse and Niehaus (2009) refer to this type of mixed method design by the following notation: “QUAL → *quan*” where QUAL refers to the qualitative core, the “arrow symbol →” refers to “sequential” and “*quan*” refers to the quantitative supplemental component (p. 25). Using the *quan* supplemental component allows for exploring relationships and testing conjectures that emerged from the QUAL results (Morse & Niehaus, 2009, p. 106). The QUAL core data was analyzed separately from the supplemental *quan* component. The qualitative data analyzed informed the refinement of some of the variables in the *quan* component and informed my thinking about the *quan* analyses.

The final step was to identify the point of interface (Morse & Niehaus, 2009, p. 25). This was the position in which the core and supplemental component met. According to Morse and Niehaus, it was important that the two operations came together at a time when both of the methods are “ready” to be combined (Morse & Niehaus, 2009, p. 55). In this dissertation, the point of interface was during the results section and these thoughts are presented in Chapter 6.

Theoretical Framework of Human Capital

The theoretical framework that guided this dissertation was the theory of human capital. Human capital is defined as training and competencies that improve productivity in one's profession (Buhr, 2010). According to traditional human capital theorist, Gary Becker, there are two types of human capital – general and specific (1964). General human capital is defined as human capital that is productive in all environments and employers. Specific human capital is defined as knowledge and skills that pertain to a specific employer.

The theory of human capital may be applied to nurses working in hospitals (Figure 3.1). Nurses acquire general human capital through formal education, state licensure exams, certification within a specialty and on-the-job experience. Nurses acquire specific human capital by learning knowledge of policies, procedures, protocols, and nursing interventions within the institution in which they work. Additionally, human capital can also be specific to a nursing unit. The culture of the unit and nursing customs can differ across units even within the same facility, so understanding unit specific human capital, which may be measured by unit tenure, may be important.

According to the theory, increasing nurse human capital can increase productivity which can benefit patients and improve efficiency. Also, an increase in productivity increases the quality of care that nurses provide. Quality nursing care can be assessed by decreased adverse events and patient length of stay both within a hospital and on an unit.

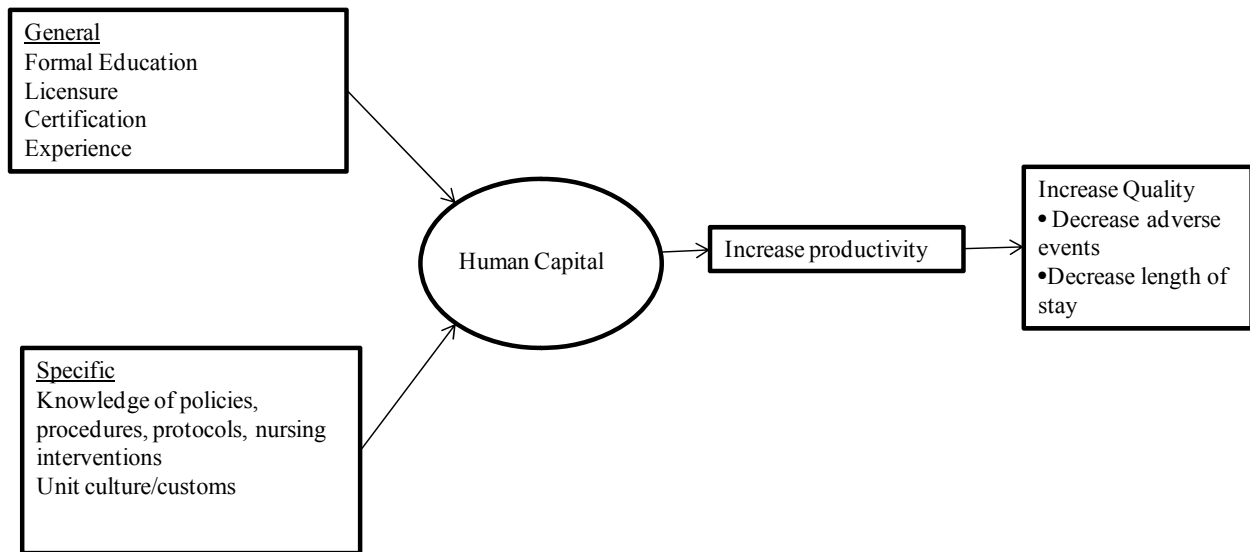


Figure 3.1 Human capital for nurses

Table 3.2 Four steps for a mixed method dissertation	
STEPS	DISSERTATION
1. Theoretical drive	1. Inductive
2. Core and supplement component	2. Qualitative core and quantitative supplement
3. Pacing	3. Sequential
4. Point of interface	4. Results

Chapter 4: Twenty-Four / Seven: Perceptions and Observations of off-shift Nursing

In this Chapter, nurse perceptions of off-shift care were explored by conducting semi-structured interviews of VA and non-VA nurses. The interview guide was developed based on the theory of human capital. The guide is available in Appendix B. Observer-as-participant observations of four units were performed. Data were analyzed using content analysis following both Morse's and Graneheim and Lundman's methodology. Six themes emerged about off-shift nursing care. The themes are presented in this chapter. A concise table of the themes are also attached in Appendix B.

Abstract

Purpose: The purpose of this paper is to qualitatively explore nurse perceptions of off-shift (e.g., nights and weekends) nursing care and quality as compared to regular hours.

Design and Methods: In-depth semi-structured interviews of 23 nurses and 4 observer-as-participant observations were conducted on both medical-surgical and intensive care units in a Veterans' Affairs (VA) hospital and a non-VA hospital. Content analysis was used to identify themes.

Findings: Three themes emerged pertinent to decreased resources and three themes emerged pertinent to decreased human capital on off-shifts. Decreased resources in terms of insufficient personnel resulted in self-reliance, but also required nurses to complete more tasks. Nurses with less experience within the facility and on the unit often worked off-shifts. Night nurses felt underappreciated for their work.

Conclusions: Decreased resources and decreased human capital on off-shifts may impact quality care delivered in hospitals.

Clinical Relevance: These findings support the importance of nurse administrators to provide sufficient resources in terms of ancillary personnel on off-shifts and balance less experienced staff on both day and night shift. Facilitating communication between night and day nurses may help allay night nurse feelings of under-appreciation.

Key words: Off-shifts, quality care, content analysis

Introduction

Nurses provide 24-hour-a-day, 7-day-a-week care in hospitals. To ensure 24-hour continuous patient coverage, it is necessary that some nurses work “off-shifts”, defined as nights, weekends, and holidays. Sometimes nurses chose to work these shifts to increase work-life balance. Even though some workers may prefer non-standard hours, such schedules seem highly stressful for families with children (Presser, 2003). Additionally, there are other situations where nurses do not have a choice in what shift they work and may be required to work undesirable shifts to ensure safe staffing.

Whether nurses work at night or during the day, many are required to work weekends. In focus groups of 14 labor/delivery and neonatal intensive care nurses, researchers found that nurses perceived differences between hospital work environments on weekends as compared to weekdays including less supervision and physician backup for emergencies; additionally, the nurses reported that the off-shift work environments on weekends and at night are similar (Hamilton, Eschiti, Hernandez, & Neill, 2007). After conducting a systematic review of staffing literature and a secondary analysis of this qualitative data, this team has also found that found that off-shift nurse staffing was inadequate on nights and weekends in critical care units (Eschiti & Hamilton, 2011).

The association of safe nurse staffing and patient outcomes is widely reported in the literature (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007) and has been the impetus for policy campaigns such as “Safe Staffing Saves Lives” (American Nurses Association [ANA], 2011). Additionally, in a recent cross-sectional study of 2,545 nurses, researchers found that higher levels of nurse staffing resulted in higher levels of teamwork among nurses (Kalisch & Lee, 2011). Nurse staffing, while extremely important, is not the only factor that can impact patient

outcomes on off-shifts; nurse human capital, which include characteristics related to training and experience may also impact quality care.

Although many studies examine nurse staffing and patient outcomes, no published studies were found that simultaneously explored nurse staffing levels and human capital on off-shifts. Additionally, qualitative work in off-shift nursing care is sparse. Only a few researchers have explored nursing work environment on off-shifts, (Eschiti & Hamilton, 2011; Hamilton et al., 2007). Furthermore, how nurses ensure quality care on off-shifts is a topic that remains to be explored. The purpose of this study was to qualitatively explore nurse perceptions of off-shift nursing and quality of care as compared to more regular hours.

Methods

Design, Setting, and Participants

The qualitative study was conducted at two hospitals: a Veterans' Affairs (VA) hospital and a non-VA hospital. Both hospitals were large, tertiary medical centers (> 850 operational beds), located in or near major metropolitan cities, and affiliated with academic medical schools. The VA and a non-VA hospital was chosen to understand if nurse perceptions in the two institutions were similar. In both settings, nurses were recruited from an acute care unit and an intensive care unit (ICU). Purposive sampling for variation was conducted to deliberately recruit nurses who worked during the day and others who worked at night, nurse managers and staff nurses, as well as nurses with varying years of experience. Characteristics such as race and ethnicity were not considered for recruitment.

Participants were recruited with the assistance of the nurse managers at the VA. In the non-VA hospital, recruitment occurred mainly by snowballing. In both settings, most interviews were prearranged and occurred during the nurses' work hours. The interviews were conducted in

private conference room on the units, however some of the ICU nurses preferred to be interviewed in a quiet area on the unit. All interviews were digitally recorded and all participants provided informed consent to participate in the study. Nurses who agreed to be interviewed were not financially compensated. The study was approved by the Columbia and Stanford University Institutional Review Boards.

Data Collection

Interviews were conducted in English using a semi-structured interview guide (available from authors) including topics such as staffing, human capital, and quality patient care. Participants were encouraged and often shared pertinent information beyond what was included on the guide. The recorded interviews lasted between 20 to 45 minutes.

Additionally, participant observation was performed on all units. The type of participant observation used was observer-as-participant (Morse & Field, 2002). This type of observation included observing the units, but not actively participating in the nursing role. Structured observations of day, night, and weekend shifts occurred during the week of June 30th through July 7th, 2010 at the VA. In the non-VA setting, observations occurred during the end of November through December 2010. During some of the observation periods, nurses were interviewed. This decision maximized data collection without burdening the unit and reducing the Hawthorne effect. After each observation, field-notes were digitally recorded or handwritten and incorporated into the analysis.

Analysis

More than half of the interviews and all field notes were transcribed by the interviewer (PdC), and the remainder were transcribed by a third party. All transcripts were double-checked by listening to the recordings to maximize transcription accuracy and understand any nuances

that may be present in the audio recordings but not present in the transcript. A constant comparative analysis was conducted; the non-VA interviews occurred while the data from the VA transcripts were being analyzed. During this time, the interviews continued to occur until saturation of data was achieved.

Data were analyzed using content analysis. After multiple reiterations of reading the transcripts, “meaning units” were abstracted (Graneheim & Lundman, 2004). Meaning units were defined as words, sentences, or paragraphs containing aspects related to each other through their content. The meaning units were condensed to shorten the length of text while still maintaining the core meaning (Graneheim & Lundman, 2004). Participant observations were also condensed into meaning units. These observations were described and then interpreted (Graneheim & Lundman, 2004). The process of extracting meaning units from observations is illustrated in Table 1. Further abstraction of condensed meaning units of interview data resulted in the creation of codes. These codes were grouped into subcategories and categories (Morse & Field, 2002). Initially ten categories were developed pertaining to nursing shifts and human capital. After each category had ample data and saturation was reached, descriptive paragraphs were written to examine relationships between categories (Morse & Field, 2002). Writing paragraphs of text assisted in the emergence of themes. Data analysis was initially conducted by the first author (PdC) and continually supervised by a senior researcher (PWS). Categories and themes were discussed with other members of the research team (CP and APB) during weekly conference calls. The processes of coding and categorizing text were facilitated with the NVivo 8® (QSR, Australia).

To address trustworthiness, several methods were used to ensure credibility, dependability, and confirmability. Member checks were used by asking three of the nurses to

provide feedback on the accuracy of the transcribed transcripts and the development of categories. An audit trail was kept in NVivo and there were weekly meetings with the research team to review codes and the emergence of themes. These themes were also triangulated with other qualitative and quantitative evidence.

Findings

Demographic Features of Participants

The sample consisted of 23 Registered Nurses (RNs) from both acute and ICUs. There were 21 staff nurses and two nurse managers interviewed, the latter managing an acute care unit and an ICU. We found no differences in perceptions between the nurse managers and staff RNs. Characteristics of the 23 RNs are presented in Table 2. Eighty-seven percent of the participants were female and 52% were older than 40. Among the 21 staff nurses, 11 worked during the day and 10 worked at night. In the past, the majority (60.9%, $n = 14$) of the RNs worked both day and night shifts and there was just 1 nurse who worked day shift only. The remaining 34.7% ($n = 8$) of the RNs interviewed worked only at night; however, this did not include the orientation period, which according to all of the nurses, occurred during the day shift. The mean years of total RN experience was 15.7 ($SD \pm 12.4$). The range of RN experience was from three months to 35 years. On average, RNs worked with the facility for over 11 years ($SD \pm 9.7$) and on the unit for almost eight years ($SD \pm 5.3$).

Themes

There were six major themes related to off-shift nursing work. Three themes emerged as a result of decreased resources on off-shifts and included 1) Collaboration among self-reliant night nurses; 2) Increasing tasks; and 3) Taking a breather on weekend day shift. Three other themes emerged as pertinent to decreased human capital on off-shifts, which included 1) Rite of

passage expectation for new nurses; 2) Mixture of RN personnel; and 3) Night nurse perception of under-appreciation.

Decreased resource themes. Nurses working off-shifts had decreased resources available as compared to those working during the day. The three themes that emerged related to decreased resources are described below.

Collaboration among self-reliant night nurses. As a result of decreased resources available, dominant perceptions that were identified among night nurses included being self-reliant and being able to work as a team. Dealing with limited resources at night caused nurses to troubleshoot, think critically, and adapt accordingly. Both day and night nurses identified the decreased resources available specifically at night. There were not as many health care providers around as there were during the day. The decreased resources in terms of less support for nurses at night required night nurses to “seek out” the resources.

The decreased presence of physicians was common at night. However, since both institutions were teaching hospitals, nurses were able to contact physicians fairly quickly because “someone was always available.” Using nursing judgment on whether to call a physician or not was a common response that is part of this theme. Prior to calling, nurses stressed the importance of “having all of your ducks in a row” or negotiating with a physician because the physician might not know the patient. As one nurse commented:

You have to be a little more independent on nights because you’re not as supported, you don’t have support staff, not all the physicians are all here, you’re you only have a intern or a resident who might or may not know, everything that has to be done for the patient.

There were decreased resources in terms of ancillary staff. As a result, night nurses

relied on each other more than ancillary staff since nursing assistants and ward clerks were not as available at night as they were during the day. Therefore, nurses utilized the resources that they had most often – themselves. Nurses commented that the “it’s just us” perception created a sense of camaraderie and teamwork. They formed “partnerships” and were “more accommodating” with each other because of the decreased ancillary staff available.

Often, there were fewer nurses available at night and night nurses compensated by increasing their camaraderie. However, night nurses often resented having less staff available. Staff night nurses perceived that nursing administration decreased nurse staffing because “it’s easier” and “slower”, which wasn’t necessarily the perceptions of current night nurses. One night nurse specifically commented on the decreased nurse staffing at night by making the following comment:

If we're shorter on nights then they [administration] let it go, because we're ‘not as busy as the dayshift.’ I see them struggling in the morning, trying to get extra staff. I see them fight, carry on, throw a temper tantrum, to get another nurse on, and they get it. Whereas the night shift if I whine about it, I'm looked at as a pain in the behind and I get no result.

Increasing tasks. On off-shifts, nurses had to complete more tasks because of less nursing assistants and ward clerks available. This increased number of tasks impacted nursing workload. Having less ancillary staff on off-shifts “has become a routine.” Nurses felt that the reason there was less ancillary staff available was because there was an administrative perception that it was “slower” on off-shifts. As a result, nurses were then required to perform ancillary staff responsibilities in addition to their own. These increased tasks included stocking linens and carts, moving patients to stretchers, helping other nurses with turning and repositioning, and

transporting patients. The decreased amount of ward clerks on off-shifts also increased nursing tasks such as answering phones, updating the patient census, creating patient labels for lab work, and filling charts. A nurse manager commented that "At the desk, putting patients into the computer, making labels is not where I want the RNs to be obviously." The increased tasks have been described by nurses as "frustrating", "overwhelming", and "challenging." One nurse said:

We add another title to us. We are 'RNs' slash 'NAs' [Nursing Assistants] and here we are ward clerks on the weekends!

In addition to decreased ancillary staff on off-shifts, there were decreased availability of other health care provider staff such as pharmacists, physical therapists, speech therapists, nutritionists, and social workers. Although the decreased availability of these providers did not necessarily increase tasks, it required the nurses to "jump through more hoops." As a result, patient care was often delayed waiting for medications or other health care provider evaluations.

Taking a breather on weekend day shift. While there were decreased resources available on off-shifts, most day nurses perceived weekend day shifts to have a more "relaxed" pace than during the week. There was less noise on the units and nurses commented about decreased movement of patients and less interruptions. For example, on weekend days, patients did not have as many routine procedures, such as endoscopies, ultrasounds, vascular exams, surgeries, or evasive testing. Some day nurses felt that more family members were present on weekends and allowed for both patient and family teaching. Generally, day nurses perceived weekends as times when they were able to "focus more on their patients." One day nurse said:

I find that Saturday and Sunday I can breathe a little better. There's less responsibility.

There's not this in, out, in, out, you know like my patient is leaving and I'm getting a new

one. It's like the patients are there for the 12 hours to actually take care of them. So there's a breather on the weekend. I mean, any nurse will tell you this.

Although weekend day shifts were perceived as slower, nurses also felt that there was a component of unpredictability that may alter the ability for nurses to take a breather. Nurses felt the unpredictability could impact nurse workload especially with increased tasks that they were required to complete.

Night nurses did not distinguish between weekday nights and weekend nights. When asked about differences between weeknights and weekend nights, the response from a night nurse was: "I don't see a big difference. I can have very light weekdays, and it can be murder during the weekend. It can vary."

Decreased human capital themes. Three other themes emerged as pertinent to decreased human capital on off-shifts. These themes are described below.

Rite of passage expectation for new nurses. There was an expectation for inexperienced nurses to work at night. Nurses perceived this expectation because new nurses had to “make a commitment” because in general, “no one wants to work at night.” There were some identified benefits of new nurses working at night such as having “time to think” and “not much activity going on.” However, there was also a concern that inexperienced nurses were working on a shift that already had decreased resources available. For example, many of the night nurses who were interviewed were experienced. The experienced night nurses perceived that “too many” new nurses at night resulted in “baby-sitting.” These nurses were required to provide support to new nurses even when support was not often available for them. The continual expectation of new nurses to work at night was overwhelming to experienced staff. For example, one nurse stated:

All new nurses go to night shift. So I'm the most senior and they call me Mama. So I'm like the Godmother to them all, and I'm not sure I like it. And I'll tell you why; it's because I have no support. I'm being the support for them; it's nice, but it can be very stressful and frustrating when there is no support for me.

This expectation was apparent to new nurses also. Two night nurses interviewed had less than two years experience. These nurses were willing to work at night when they applied for their first job. Neither of them was dissatisfied with this expectation. Additionally, nurse managers were clear that night shift “is what they hire to.” In fact, all newly hired nurses, regardless of experience level were only offered night shifts. New graduate nurses were grateful to have a position despite the expectation of them to work at night. A newer nurse said:

To be honest, I had very little choice because I was pretty desperate for a position. And this one came and one of the things available. I kind of took what was in front of me.

Mixture of RN personnel. In addition to the nurses with less general human capital working at night, there were also several nurses with less specific human capital that worked off-shifts. This mixture of nurses included agency, traveler, and/or per diem nurses. According to the staff nurses, managers would use these nurses to fill vacancies to ensure consistent staffing levels. These types of nurses were used less frequently on more regular hours. Nurses felt that nurses who had less specific human capital did not impact quality care. In fact, one VA ICU nurse spoke of the benefits of using agency nurses at night:

We don't use them [agency nurses] during the day shift which I'm not sure why. We use them on the night shift and they are godsend because most of them are nurses that worked here before, they retired and decided they didn't like retired life and they come back through

an agency so they are very familiar.

The VA nurses perceived agency nurses as sometimes “better than the regular staff” because agency personnel have to be trained to use the electronic medical record system prior to working as an agency nurse. This perception was not shared by nurses interviewed in the non-VA setting. In the non-VA setting the night nurses were concerned when agency nurses were not as familiar with the institution. In addition, some agency nurses often had both less general and specific human capital. Overall, nurses in both facilities agreed that an agency nurse was better than no nurse at all on off-shifts. This non-VA acute care night nurse spoke about agency nurses:

At night we usually have a lot of different types of nurses...you can tell the inexperience, so we tend to get travelers, per diem, agency nurses. A per diem nurse actually gets hired by the floor, and so they are supposed to be specific to the floor. But an agency nurse can float anywhere in the hospital. So you have to be on your toes sometimes with the agency nurse, they're not familiar with the medicines, and they're not familiar with what to do in certain situations. So you're a little more guarded, because anything can happen during that time.

Night nurse perception of under-appreciation. Another theme that emerged pertaining to decreased human capital was lack of appreciation for night work. Night nurses agreed that there was a “universal consensus” that night nurses “don’t do anything.” They perceived that day nurses felt that “they work harder” and “night shift is easier than the day shift.” Night nurses also perceived that day nurses there was more time at night and therefore night nurses could complete nursing responsibilities that were not completed during the day. Night nurses expressed that “patient care is 24 hours” and the “busy patient during the day is the same patient

at night.” One night nurse stated:

My saying was always, ‘We’re the security guard with the flashlights while they are the cops with pistols.’ That’s how they perceive themselves. Yeah, they come in...in the cars, squad cars while we ride around on little scooters, shine the flashlight. And that’s not how it goes!

The day nurses in this study did not perceive that night shift was easier or that they work harder than night nurses. In fact, the majority of day nurses worked at night previously. However, the day nurses spoke about differences in pace at night as compared to during the day. For example, day nurses perceived day shift as a lot of “hustle and bustle” and “constant activity.” Although night nurses perceived to be under-appreciated for the work that they do, day nurses recognized the importance of nursing care at night. A nurse manager described the importance of night work:

When your patient *really* appreciates nursing care, is on the midnight shift because if you’re worried, or scared, and you can’t really sleep, I mean, someone, someone that’s there, a midnight shift nurse can make a lot of difference to a patient and *nobody* would ever know.

Discussion

There were six major themes that emerged about off-shift nursing and the quality of patient care. Three of the themes pertained to decreased resources and the remainder pertained to decreased human capital. With decreased resources, night nurses were self-reliant and worked as an efficient team. On weekends, there were fewer interruptions from administrators, physicians, and patients having procedures that allowed day nurses to focus more on patient care. However, the decreased support services in terms of ancillary personnel led to increased nursing tasks. This decreased support on off-shifts may impact nursing workload, delay patient care and

ultimately decrease the quality of the care delivered.

According to the theory of human capital, with high human capital, nurses improve their productivity, which benefits them, their workplace, and patients (Buhr, 2010). We found that nurses with less human capital were expected to work at night. Experienced night nurses were responsible for overseeing inexperienced staff with limited support. Additionally, nurses with less facility and/or, unit-specific human capital were expected to work the off-shifts. In this study, staff mixture was not perceived as a detriment; nurses preferred being watchful of agency personnel as opposed to not having a nurse at all.

In the literature, staff mixture (often defined as skill-mix) has been studied as a component of adverse patient events. Recently, researchers examined 115,062 nursing shifts in 13 military hospitals and found that a decrease in the percentage of civilian nurses as compared to military nurses was associated with a maximum of a 48% increased likelihood of falls and a 67% increased chance of medical errors (Patrician et al., 2011). Authors explained this result as differences in years of experience between civilian and military nurses (Patrician et al., 2011). Specifically, examining the staff mixture of agency and non-agency nurses on quality care is another topic for future research.

An interesting finding is that day nurses perceived differences between weekdays and weekends, whereas night nurses did not distinguish between weeknights and weekend nights. An explanation may be because night shift is by definition an “off-shift” in terms of resource adequacy. Night nurses may be accustomed to working with decreased resources and did not perceive differences by the day of the week.

Another surprising finding is that an overwhelming majority of nurses had worked night

shift throughout their career. During recruitment, the interviewer was unaware that day nurses who agreed to participate in the study have had experience on both shifts. However, this finding strengthened the emergence of themes since current day nurses were able to share their perception of night nursing as well.

In this qualitative study, decreased resources themes on off-shifts are similar to what other qualitative researchers have found when interviewing nurses. In a qualitative study of 38 critical care nurses in the southwestern United States, researchers found that inadequate nurse staffing, support services and non-nurse staff are greatly diminished on these off-shifts (Eschiti & Hamilton, 2011). In our study, while a few nurses commented about concerns related to decreased nurse staffing on off-shifts, the limited support services and non-nurse staff impacted nursing work.

The theme of night nurses being self-reliant is also similar to other qualitative research. In a study of 18 nurses in Iran, researchers interviewed nurses and found that working at night, meant being independent and more skilled as a nurse (Nasrabadi, Seif, Rasoolzadeh, & Emami, 2009). However, there are differences between healthcare systems in Iran and the United States, therefore future qualitative studies of off-shift nursing are recommended.

The theme of night nurses feeling underappreciated is also consistent with existing research. Nilsson, Campbell, & Andersson (2007) found that night staff experiences its work as being largely invisible and not always appreciated by the day staff. Additionally, night shift nurses often feel frustrated with their needs being ignored (Smith, 2010). Contrarily, the day nurses interviewed in this study did not voice lack of appreciation for night work. An explanation may be that the majority of the day nurses interviewed have also worked at night and

understand night nurses perceptions.

Based on the findings, there are some implications for nursing practice. The most important implication for nurse administrators is to consider both nurse staffing and experience level when developing off-shift staffing plans. It is equally important for nurse administrators to evaluate the decreased amount of ancillary personnel on off-shifts available. The findings from this study suggest that decreased ancillary personnel increases tasks which may increase nurse workload. Although it is recognized that night positions are often the hardest to fill and the least desirable, it may behoove administrators to try to balance less experienced personnel on both day and night shift.

There is also a need to increase support for existing night nurses. Nurse administrators should engage night nurses and encourage open communication between both shifts. To reduce feelings of disengagement from daytime operations, administrators and day-shift employees can also acknowledge situational differences between night and day shifts and value night nurses (Claffey, 2006). This can be accomplished by involving night nurses in decision making both on the unit and within the hospital. Also administrators may engage more night staff by ensuring night nurses are included in meetings and in-services. Night nurses may have difficulty attending programs offered during the day due to conflict with other personal responsibilities (Stewart, Snyder, & Sullivan, 2010).

There are limitations to this study, including the fact that the nurses came from only two settings, and both groups of nurses worked in metropolitan hospitals affiliated with medical school. Although we did not find differences between a VA and a non-VA hospital, these nurses may not share perceptions of nurses working in community and/or rural hospitals that are smaller

and not affiliated with a teaching institution. Additionally, only two nurse managers were interviewed representing both an acute care unit and an ICU. Although we did not find differences between the staff nurses and nurse managers, with the small sample caution is needed interpreting these findings. Another limitation may be that nurses who agreed to be interviewed ranged in years of experience. For example, one nurse interviewed was a nurse for only three months. However, nurses were purposively recruited with varying degrees of experience to include new nurse perspectives and saturation of data was achieved. Also, the researchers did not ask the nurses about educational preparation, which is another limitation of this study. Finally, despite informing participants that there were no wrong answers, nurses may have been reluctant to share their true perceptions because of social desirability.

Conclusion

Based on the perceptions and observations in this single study, there are decreased resources available to nurses on off-shifts. Additionally, the findings from this study suggest that there is decreased human capital on off-shifts. Some themes pertained mainly to nights and others to weekends which may inform future quantitative work. There may be specific differences between nights and weekends. Additionally, how experience impacts quality of care on nights should also be examined. Examining the associations of staffing (RN hours and skill-mix of nursing hours) and human capital variables on quality patient outcomes may inform policy decisions and improve off-shift care. Although night nurses have developed skills in which they work both independently and as a team, decreased staffing in terms of nurse and ancillary personnel on off-shifts may impact patient safety. Additionally, the inexperience and the staff mix of the nursing workforce on off-shifts may impact the quality of nursing care that is delivered.

Clinical Resources

- Agency for Healthcare Research Quality Personal Safety for Nurses:
http://www.ahrq.gov/qual/nursesfdbk/docs/TrinkoffA_PSN.pdf
- Medscape Patient Safety: <http://www.medscape.com/resource/patientsafety>
- Other researchers examining off-shift nursing: <http://nursingopen247.com/>

Table 4.1. Observer-as-Participant observations supporting themes				
Meaning unit	Condensed meaning unit: Description	Condensed meaning unit: Interpretation	Sub-theme	Theme
Night nurses told other nurses to "watch" their patients while interviewing whereas day interviews were prearranged.	Night nurses "watched" other patients frequently	Night nurses used teamwork to watch over other patients	Decreased resources	Collaboration of self-reliant night nurses
In both settings, medical personnel were on the unit during the day. At night, the medical personnel were available, but not always present on the unit.	Medical doctors in ICUs were mostly on the unit during the day	Obvious presence of medical personnel during the day		
Other healthcare providers such as physical, speech, occupational, and respiratory therapy were on the units during the day. These personnel were not as visible on off-shifts.	Other healthcare providers were on the unit more during the day	Other healthcare providers were not as available on off-shifts	Decreased human capital	Rite of passage expectation for new nurses
On off-shifts, there was less presence of nursing assistants and ward clerks in both settings.	Less presence of ancillary personnel on off-shifts	Ancillary personnel not always available to help nurses on off-shifts		
At night, in both acute care and ICUs, researcher had to wait to interview since RNs were turning and repositioning patients.	Waiting to interview night nurses		Decreased human capital	Mixture of RN personnel
In both settings, less experienced nursing staff worked at night as compared to during the day. However, in both settings, there were also a core group of experienced nurses working.	Less experienced staff worked at night, however, there was also core of experienced staff	Less experienced staff work at night		
During an interview with an experienced night nurse, she was interrupted a few times by less experienced staff asking questions.	Less experienced staff asked questions of experienced personnel	Experienced night nurses act as resource to less experienced nurses	Decreased human capital	Mixture of RN personnel
On a weekend night in the non-VA setting, there were 3 nurses who were "floated" to the ICU.	Floating occurs most often on weekend night shift	Nurses with less facility-specific human capital work at night		
On a holiday weekend, full-time, part-time and per diem nurses worked in the ICU.	Mixture of nurses work on holidays and weekends	Mixture of nurses work to ensure appropriate staffing		

Table 4.2. Demographic features of nurse participants

Category	n = 23	%
Age (years)		
< 40	11	47.8
> 40	12	52.1
Sex		
Female	20	87.0
Male	3	13.0
Department		
Acute care	13	56.5
ICU	10	43.5
Position		
Staff nurse	21	91.3
Nurse manager	2	8.7
Current shift*		
Day shift	11	52.3
Night shift	10	47.6
Shift in the past		
All shifts	14	60.9
Day shift only	1	4.3
Night shift only	8	34.7
Started on night shift as a new nurse		
Yes	22	95.7
No	1	4.3
Experience (years)	Mean	SD
RN	15.7	12.4
Facility	11.1	9.7
Unit	7.4	5.3

Notes: *Sample does not include nurse managers; RN = Registered Nurse

Chapter 5: Twenty-Four/Seven: The Association Between Night Nursing Inputs on Length of Stay

In this Chapter, the impact of variations in total nursing inputs (*i.e.*, staffing, and human capital variables) and night nursing inputs on length of stay (LOS) in acute care units at Veterans' Affairs (VA) hospitals was examined. Using a panel, longitudinal unit-level dataset from 2003 through 2006, staffing and human capital variables were analyzed. Descriptive statistics were performed and differences between day and night hours were examined. To break the correlation between the total and night nursing inputs, these independent variables were demeaned and the correlations were examined. Multivariable fixed effects regressions were used to test the association between demeaned staffing and human capital variables and LOS. The quantitative results from this portion of the dissertation are presented in this chapter.

Abstract

Purpose: As part of a larger mixed-methods study, the purpose of this paper is to quantitatively examine the effects of variations in total and night nursing inputs on length of stay (LOS) in acute care units at Veterans' Affairs (VA) hospitals.

Design and Methods: Guided by the theory of human capital, an existing longitudinal, unit-level dataset of VA patient and employee data from the years 2003 through 2006 was used. Nursing inputs included staffing (hours per patient day [HPPD], percent of HPPD provided by licensed practical nurses [LPN] and unlicensed assistive personnel [UAP]) education (percent of hours provided by associate degree nurses and percent of hours provided by baccalaureate prepared nurses [BSN]) and experience (average prior experience, unit tenure, facility tenure and VA tenure). For all independent variables the totals (regular and nights) and off-shift (nights) were demeaned. Controlling for patient, unit, and nursing characteristics, fixed effects regressions were used to test the association between staffing and human capital and LOS.

Results: There were 8,243 acute unit-monthly observations. Total HPPD was higher during the day than at night (4.26 vs. 3.44, $p < 0.01$). The percentages of hours worked by BSN nurses were also higher during the day than at night (37.0% vs. 35.5%, $p < 0.01$). Generally, tenure was higher at night than during the day. In multivariable, fixed effect regression models, night HPPD was negatively and significantly associated with LOS ($\beta = -0.034$, $p < 0.001$). When education variables were added to the model, HPPD remained to be negatively and significantly associated with LOS ($\beta = -0.034$, $p < 0.001$). An independent effect of night staffing was found beyond the total staffing effect.

Conclusions: There was less staffing, less educated nurses, and more experienced nurses at night. Higher nurse staffing at night was associated with decreased LOS. Although skill mix,

education and tenure are important to quality care, these factors may not necessarily need to be similar during the day and at night. Administrators should consider all nurse workforce characteristics (staffing, education, and experience) when developing night staffing plans.

Introduction

Patients admitted to hospitals on off-shifts (nights and weekends) are more likely to die than patients admitted on more regular hours (Barba et al., 2006; Barnett, Kaboli, Carl, & Rosenthal, 2002; Bell & Redelmeier, 2001; Cram, Hillis, Barnett, & Rosenthal, 2004; Kostis et al., 2007; Laupland, Shahpori, Kirkpatrick, & Stelfox, 2008; Pilcher, Duke, George, Bailey, & Hart, 2007; Saposnik, Baibergenova, Bayer, & Hachinski, 2007; Schilling, Campbell, Englesbe, & Davis, 2010; Wunsch, Mapstone, Brady, Hanks, & Rowan, 2004). These differences may be related to less healthcare personnel and procedures available. Also, employees who worked at night and/or rotated to work at night report higher fatigue and stress than employees who worked during the day (Arora et al., 2006; Barnes-Farrell et al., 2008; Choobineh, Rajaeefard, & Neghab, 2006; Geiger-Brown, Muntaner, Lipscomb, & Trinkoff, 2004; Gold et al., 1992; Horwitz & McCall, 2004; Jamal & Baba, 1992; Korompeli, Sourtzi, Tzavar, & Velonakis, 2009; Leff et al., 2008; Ruggiero, 2003). Higher rates of fatigue have been associated with poor quality patient care (Rogers, 2008). Also, it has been reported that new graduate nurses who are required to work at night suffer from sleep disturbances, however, some adaptation to night shift occurred by twelve months (West, Ahern, Brynes, & Kwanten, 2007). Although there is some evidence suggesting that patient safety outcomes suffers on off-shifts, the underlying mechanism for this association is not well understood.

Nurses are responsible for providing 24-hour, 7 day-a-week care to patients. Currently, a large body of evidence supports the association between nurse staffing and patient outcomes; however, studies examining off-shift nurse staffing and patient outcomes is sparse. Additionally, nurse staffing, while extremely important, is not the only factor that can impact patient outcomes on off-shifts. Other characteristics related to the nurses' training, education and experience may

also impact quality care. Currently, no studies exist that simultaneously consider nurse staffing and the characteristics of the nursing workforce on various shifts and how that can affect patient outcomes. Using a four-year panel of monthly, unit-specific data, the purpose of this study was to examine the effects of nursing inputs during the day as compared to night on length of stay (LOS) in Veterans' Affairs (VA) hospitals.

Theoretical Framework

This study was guided by the theory of human capital, which conceptualizes employee characteristics as components of human capital (Becker, 1964). Specifically, human capital is defined as training and competencies that improves productivity in one's profession (Buhr, 2010). Human capital is important because the capacity of an organization to function effectively as a production unit is determined largely by the level and meshing of the skills of the employees (Prescott & Visscher, 1980). There are various types of human capital including general and specific (Becker, 1964). Nurses acquire general human capital through formal education, credentialing, and on-the-job experience. General human capital is specific to the employee (*e.g.*, the nurse) no matter where the employee works. By increasing general human capital, nurses improve their productivity, which benefits them, their workplace, and patients (Buhr, 2010). Human capital can also be setting specific. Facility- and unit-specific human capital refers to knowledge of various systems, policies, procedures, and protocols used in a specific facility or nursing unit.

Qualitative analyses were completed and informed the quantitative work reported here. In previous qualitative analysis, nurses perceived distinct differences in night shift workload compared to day shift (Chapter 4). The differences between working weekdays and weekends

were not perceived to be as disparate, especially on the nightshift (Chapter 4). Therefore, in this study, staffing and human capital variables on day and night hours were only considered.

Methods

Study Design

This analysis is part of a larger mixed-method study of off-shift nursing and quality patient outcomes (R36HS018216-01 and HX000361-01A2). An existing longitudinal, unit-level dataset of VA patient and employee data from the years 2003 through 2006 was used. The dataset included unit specific, monthly data from multiple VA hospitals that has standardized data elements across its member hospitals. Institutional review board approval was obtained from both Stanford and Columbia University.

Data

Data were obtained from several sources (Appendix C, Table 1). Total nursing hours data were obtained from the VA decision support system, the account level budgeter cost center, and the account level budgeter hours. Nurse characteristics data were obtained from VA payroll data, which included information on age, VA hire data, start date at the VA facility and the unit, and nursing position (*i.e.*, Registered Nurse [RN], Licensed Practical Nurse [LPN] or Unlicensed Assistive Personnel [UAP]). Patient data were obtained from patient discharge abstracts. The discharge abstract was a separate record for each "bed section" of a patient stay that was defined by the specialty of the treating physician. From the discharge abstract, the age of the patient, LOS and Diagnosis Related Groups (DRGs) were abstracted. Unit characteristics included the type of unit and patient volume (*i.e.*, the number of admissions and discharges), which was obtained by the VA decision support system.

Unit of Analysis

The following variables were computed as unit-level averages from monthly data. In the VA dataset, intermediate and mixed acute care units were defined as sub-acute care units. From preliminary analyses, there was variation between these sub-acute units and general acute units. Therefore, sub-acute unit observations were dropped.

Outcome Variable

Length of Stay (LOS). Patients' LOS is an important quality outcome measure as it increases with many different adverse events, represents a combined indicator of adverse patient outcomes and efficiency, has been endorsed by the National Quality Forum as an important quality outcome measure for hospitals and has been associated inversely to nurse staffing (Kane et al, 2007; NQF, 2008). For these reasons, LOS is an important quality indicator from both the patient and hospital administrator perspective. For these analyses, the LOS variable was measured at the unit-level and defined as the average total hospital LOS for patients discharged in the month/year of the observation.

Nursing Inputs - Independent Variables

Each variable listed below was calculated as a total representing hours across all shifts. Additionally, night and day hours were then separately identified in the VA payroll data based on the 10% night shift pay differential, which began at 6PM at night.

RN/LPN/UAP staffing. The VA budget system tracks nursing personnel hours appropriated to each nursing unit by type of personnel- RNs, LPNs, and UAPs. Productive work hours excluded vacation and sick time, but included education time (*e.g.*, when a nurse attended an in-service program). Worked hours also included instances when nurses worked on different

units that were not their primary unit (*i.e.*, floating). An adjustment for floating was made based on an average percentage of work effort allocated to other units.

For each personnel type, an average hour per patient day (HPPD) variable was created for each month based the payroll hours divided by patient bed days. The bed days variable was derived from the VA decision support system intermediate product detail and ward files, which attributed number of bed days to units. Total nursing HPPD was calculated by summing HPPD for RNs, LPNs, and UAPs. Skill mix, defined as the proportion of RNs, LPNs, and UAPs providing direct patient care, was also analyzed. Percent of HPPD provided by LPNs and UAPs were calculated.

Human capital variables. General human capital was measured by education and experience. Education variables were calculated as the percentage of hours worked by nurses with either an associate or a baccalaureate degree night and day hours. Experience variables included prior experience, (*i.e.*, the number of years the nurse worked as an RN prior to joining the VA) as well as unit, facility, and VA tenure. Unit tenure variables were constructed from payroll data only available from fiscal year 1995. Therefore, this measure was truncated at 11 years or more on the unit. Both the facility and the VA tenure variables were from actual hire dates, and were not censored. All tenure variables were weighted by the actual hours worked by each of these nurses during the month.

Covariates. Patient, unit, and nurse characteristics were controlled for in the regression models. Patient covariates included age, DRG weights, and the Elixhauser co-morbidity index. Unit covariates included the unit type and the number of admissions to the unit for the month. Nurse covariates included the percent nurse contract hours.

Statistical Analysis

Summary statistics were computed to describe LOS for each unit type and then aggregated to all acute care units. Descriptive statistics and *t*-tests were computed to determine differences between the acute care day and night staffing and human capital variables. Additionally, sufficient power for statistically significant differences were considered (Appendix C).

In the regression models, the LOS variable was log transformed to address the normal distribution assumption. Prior to running regressions, all of the independent variables in the regression models were demeaned by year averages to remove the year effects. This process included demeaning the totals (regular and night) and the off-shift (night) variables to break correlation between the totals and the off-shift variables. For each staffing and human capital variable, a mean of that variable was generated by year. The mean variable was then subtracted from the original variable. Correlation coefficients for non-demeaned and demeaned variables were calculated and are presented in a correlation matrix.

All multivariable models were analyzed using fixed effects, which controlled for unobservable differences (that is the variation within units over time). Time dummies were created to control for time effects in the model. The regression models accounted for clustering because units in the same hospital may be similar to each other. All data were analyzed using STATA 11.1 (Stata Corporation, College Station, Texas).

Results

There were 8,243 acute unit-monthly observations from the year October 2002 - September 2006 including 185 acute care units. Among the acute care units, medical units were the most common (Table 5.1) and the mean LOS was approximately 6 days.

Table 5.2 displays the summary statistics of the staffing and human capital variables and the *t*-tests for differences between day and night hours. All variables were significantly different by day and night hours with *p* values less than 0.01. Among the units, HPPD was greater during the day than at night for all types of nursing personnel. Additionally, the percent of HPPD provided by LPNs and UAPs were slightly higher during the day than at night (22.8% vs. 22.1%, *p* <0.01; 17.6% vs. 11.3%, *p* <0.01 respectively).

The educational preparation of nurses was higher during the day than at night. On the units, 37.0% of the hours worked during the day were provided by baccalaureate degree nurses as compared to 35.5% of the hours at night (*p* <0.01); and, the mean percentage of night hours worked was slightly higher for associate degree nurses than the mean percentage during the day (45.3% vs. 43.2%, *p* <0.01). Other human capital variables included prior experience, unit, facility, and VA tenure. Prior experience was the only variable that was slightly higher during the day than at night (3.49 years vs. 3.43 years, *p* <0.01). All nurse tenure variables were higher at night than during the day. The greatest difference between night and day was VA tenure. For example, at night, acute care units had nurses a mean of 9.3 years of VA experience compared to 7.6 years of experience during the day (*p* <0.01).

There was high correlation between total HPPD and night HPPD prior to demeaning (*r* = 0.97, *p* <0.001) (Appendix C, Table 2). There was only moderate correlation (*r* = 0.49, *p* <0.001) between the demeaned total day and night staffing and night staffing (see Table 5.3). However, there was high correlation (*r* = 0.77, *p* <0.001) between the demeaned total percent HPPD provided by LPNs and night percent of HPPD provided by LPNs. Additionally, there was high correlation (*r* = 0.81, *p* <0.001) between the total percent of HPPD provided by UAPs and night percent of HPPD provided by UAPs. However, all of these

correlation coefficients were less than non-demeaned variables. Examining the demeaned human capital variables, there were moderate to high correlation between unit, facility, and VA tenure. The highest correlation ($r = 0.83, p < 0.001$) was between total VA tenure and night VA tenure; although, unit, facility, and VA tenure was moderately correlated among all of the human capital variables. For the demeaned education variables, there were also moderate correlation coefficients.

Two multivariable fixed effects regression models were analyzed. The specifications for both models included the demeaned totals (regular and night) and the demeaned night staffing and human capital variables. The first model estimates of demeaned total and night staffing and human capital without education variables (Table 5.4). In this model, total HPPD, night HPPD, and total percent of HPPD provided by UAPs were significant. Night HPPD was negatively and significantly associated with LOS ($\beta = -0.034, p < 0.001$). This independent effect of night staffing was found beyond the total staffing effect. Therefore, as night HPPD increased, the LOS on the units, decreased. This staffing variable, HPPD was the only night variable that was significant. There was no independent effects of night skill mix, tenure, or education.

Table 5.5 displays the results from model two. In this model educational variables were added to the regression. There were no significant effects of differences in education on LOS. Similar to the previous model, the association between night HPPD is negatively and significantly associated with LOS ($\beta = -0.034, p < 0.001$).

Discussion

This is the first study examining differences in total staffing and human capital variables and night staffing and human capital variables and how these differences may impact LOS. In acute care, there were differences between staffing and human capital on day shift as compared

to night shift. At night, there were less staff, and the RNs were less educated and had less prior nurse experience. However, the RNs working at night, had higher unit, facility, and VA tenure.

Based on the results of both multivariable regression models, there was a difference between total staffing and night staffing. In fact, an independent effect of night staffing was found beyond the total staffing effect; this means night staffing is important. This finding was consistent with other research examining patient complications at night. In a cohort study of 569 adult ICU patients, researchers found that patients with fewer nurses at night had an increased risk of re-intubation (relative risk 5.7; 95% CI 2.4-13.7; $p < 0.001$) and pulmonary failure (relative risk 3.6; 95% CI 1.3-10.1; $p = 0.006$) (Dimick et al., 2001). The same research team also found a 39% increase in hospital LOS when ICU nurses cared for three or more patients at night (Amaravadi et al., 2000).

The results of these regression models also suggest that there was larger effect of night staffing ($\beta = -0.034$, $p < 0.001$) than total staffing ($\beta = -0.016$, $p < 0.001$). These findings may also suggest that night staffing has a larger effect on LOS than day staffing. This result is particularly important for practice, policy, and research implications. Currently, it is widely accepted that a large body of evidence exists that poor nurse staffing is associated with worse patient outcomes (Kane et al., 2007), however as mentioned previously, the existing evidence on studying the association between nighttime nurse staffing and patient outcomes is sparse. Recently, Needleman et al. (2011) found over a four-year period (2003-2006) that at 29.7% of 11,650 night shifts compared to 13.7% of 11,663 day shifts were below a target level of nurse staffing in one institution. These researchers found that there was a significant association between increased mortality when RN staffing was below the target level compared to a target level for nurse staffing (hazard ratio 1.02; 95% CI 1.01-1.03; $p < 0.001$). (Needleman et al.,

2011). In this study, the results suggest that decreased nurse staffing at night may increase LOS even more so than the decreased staffing during the day. Therefore, decreased night staffing may be more detrimental to patients than decreased day staffing. Nurse administrators should be aware that patient outcomes may be worse at night because of decreased staffing. Further studying patient outcomes by shift level is recommended.

There was no difference between skill mix during the day and at night. This was a surprising finding; while no other research was found examining associations between the differences in skill mix by shift and LOS, overall skill mix has been found to be an important component in nurse staffing. For example, in a recent cross-sectional study of 2,545 nurses, researchers have found when there are higher proportion of skill mix (*i.e.*, more RNs in the mix), the greater the overall teamwork on the unit ($\beta = 0.436, p = 0.009$) (Kalisch & Lee, 2011). This team also found when teamwork was stronger, less missed nursing care was reported by staff nurses (Kalisch & Lee, 2010). Our findings suggest that while skill mix is an important component to staffing, the skill mix across shifts does not necessarily need to be similar.

Examining the human capital variables, the effect of unit, facility, and VA tenure was no different at night than it was during the day. Additionally, adding the education variables in model 2 did not change the results from model 1. Therefore, the effect of human capital including education and experience was not more important at night than it was during the day. An explanation for this finding may be that unit, facility, and VA tenure were higher at night as compared to during the day. In contrast, education preparation was higher during the day, than at night. These relationships may counterbalance an effect on LOS. Therefore, higher experience at night may be sufficient in maintaining quality care despite a slightly less educated workforce.

This is the first study to examine variation in education across shifts. While the literature is sparse examining the effect of RN education on patient safety outcomes, there are a few published studies that have found a positive association between RN education and patient safety (Ridley, 2008). In these studies, the patient safety outcomes indicators included mortality and failure-to-rescue (Ridley, 2008). For example, Aiken, Clarke, Silber, Sloane, & Silber (2003) found that each 10% increase in the proportion of nurses with higher degrees decreased the risk of mortality and failure-to-rescue by 5% after controlling for patient and hospital characteristics. In a more recent study of 1,283,241 patients, the team found a significant effect of the percentage of BSN nurses on 30-day mortality and failure-to-rescue and no effects of experience or certification (Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011). Quality outcomes in these studies often include mortality and failure-to-rescue. The paucity of significant findings related to education and other quality outcomes may be due to difficulty measuring nursing processes related to knowledge, comprehension, application, critical thinking or clinical judgment. Additionally, the complex nature of the clinical setting with potentially different needs for nurses across shifts may also be a potential explanation for scarcity of significant finding

No studies exist that suggest that high tenure were negatively associated with patient outcomes. Lack of these studies may be related to publication bias. If researchers found that high levels of experience despite the nurses' educational background were inversely related to patient outcomes, publication of these results may diminish the importance of educational preparation. Additionally, lack of prior literature may be related to the overlapping of education and experience findings that results in negative findings.

Strengths, Limitations, and Future Research

This study had both strengths and limitations. Strengths included the VA unit-based, longitudinal dataset. Much of the previous researchers studying nursing factors and patient outcomes have been limited to cross-sectional analyses because of the decreased availability of longitudinal data. Although access to longitudinal data is increasing, most researches still need to use the hospital as the level of analysis due to lack of access to unit-level data (Unruh, Russo, Jiang, & Stocks, 2008). Recently, Sales et al. (2008) examined the association of RN staffing and skill mix with in-patient mortality at both the hospital and unit level. This team found that the results of statistically significant results of nurse staffing and skill mix varied depending on the level of analysis (Sales et al., 2008). However, our study is limited by using unit-level outcome data and the potential for endogeneity bias between LOS and HPPD. To reduce this risk, patient-level analyses are recommended.

Another strength was the uniqueness of the dataset. Data included patient, nurse, unit, and facility characteristics that could be used for several different analyses. However, the dataset was created from several different administrative sources, which has inherent limitations. For example, the unit tenure variable was created from the payroll data, which was truncated back to 1995.

Using the fixed effects analysis was appropriate and decreased the risk of omitted variable bias. However, there are still some variables that could have strengthened the analysis. For example, nurses were not the only healthcare providers that may have impacted quality care. Including data on physicians, ward clerks and/or other ancillary personnel is recommended. Additionally, while percent of hours provided by HPPD of agency nurses were controlled for, the variation across shifts could not be examined due to limitations in the data.

In this study unit type was controlled for, however differences between medical and surgical units in terms of staffing and human capital variables were not examined. As presented in Table 5.1, medical units in acute care have long LOS. Possible explanations may include chronic medical diagnoses that required more nursing personnel and experience. Additionally, in a study of 396 ICU patients, researchers found that medical patients were significantly younger ($p = 0.048$), had a higher severity score ($p = 0.029$), stayed longer in the ICU ($p = 0.0017$) and their ICU mortality was higher (35.2% vs. 16.5%, $p < 0.001$) (Kiekkas et al., 2008). Therefore, examining staffing and human capital at night separated by type of medical and surgical units may be useful in future studies.

Finally, this study only focused on nurse staffing and human capital on day and night hours. The decision was made based on the qualitative analyses. Future work should include other off-shifts such as weekends.

Practice and Policy Recommendations

There were more staffing resources during the day than at night. Additionally, staffing was more important at night than during the day for decreasing LOS on acute care units. Practice implications for administrators include ensuring similar staffing resources at night as during the day to decrease LOS. Also, based on these findings and the qualitative findings (Chapter 4) encouraging nurses to participate in discussions about how they can participate in determining staffing plans at night may be beneficial. The Registered Nurse Safe Staffing Act of 2011 (S.58/ H.R. 876) empowers nurses to inform administrators through staffing committees on developing appropriate staffing plans (ANA, 2011). As a result, seven states have already passed safe staffing laws based on this act (ANA, 2011). Nurses participating in staffing

committees within their institutions may contribute to night staffing plans that are consistent with day staffing plans.

In addition to staffing, administrators should consider all three nursing inputs (*i.e.*, staffing, education preparation, and experience) when developing staffing plans. Findings from this study also suggest that when night nurses have a high degree of setting specific experience, skill mix and education may not necessarily need to be the same on days as at night. However, encouraging nurses to achieve higher educational preparation is in alignment with current policy recommendations. The Institute of Medicine's Future of Nursing Report recommends nurses to achieve higher educational preparation to meet the demands of an evolving healthcare system (Initiative on the Future of Nursing, 2010, p.41). This recommendation may become even more important when there are less experienced nurses available.

Table 5.1 Mean LOS by type of acute care units

Type of Units	N	LOS			
		SD			
		Mean	Overall	Between	Within
Medical	3789	6.23	2.40	1.85	1.55
Mixed Medical/Surgical	2005	5.74	1.50	0.92	1.18
Other Medical	189	7.05	2.23	1.37	1.90
Step-down	482	5.85	2.66	1.15	2.40
Surgery	1694	6.09	2.21	1.39	1.72
Telemetry	84	5.43	1.45	0.77	1.26
Total Observations	8243				
Total Mean		6.07	2.08	1.24	1.67

Notes: LOS = Length of Stay

Table 5.2. Summary statistics of monthly unit-level staffing and human capital variables

	Day Hours (0700 - 1800)				Night Hours (1801 - 0659)				
	Mean		SD		Mean		SD		p value
	Overall	Between	Within	Within	Overall	Between	Within		
Staffing									
RN HPPD	2.85	1.61	1.42	0.76	2.23	1.26	1.13	0.57	<0.01
LPN HPPD	1.01	0.97	0.88	0.41	0.81	0.82	0.76	0.33	<0.01
Aide HPPD	0.76	0.85	0.78	0.35	0.40	0.50	0.46	0.20	<0.01
Total HPPD	4.26	2.05	1.72	1.12	3.44	1.76	1.53	0.89	<0.01
% of HPPD provided by RNs	67.94	0.18	0.16	0.09	66.56	0.18	0.16	0.09	<0.01
% of HPPD provided by LPNs	22.80	0.16	0.14	0.08	22.17	0.16	0.14	0.07	0.01
% of HPPD provided by UAPs	17.57	0.16	0.15	0.08	11.26	0.11	0.10	0.05	<0.01
Education									
% Associate	43.24	0.21	0.19	0.08	45.34	0.21	0.19	0.08	<0.01
% BSN	37.00	0.18	0.17	0.07	35.45	0.20	0.18	0.08	<0.01
Experience									
Prior experience	3.49	1.88	1.75	0.67	3.43	2.20	2.09	0.72	<0.01
Unit tenure*	4.13	2.11	1.98	0.72	5.03	2.85	2.72	0.89	<0.01
Facility tenure*	6.50	3.22	3.04	1.11	7.18	3.77	3.55	1.25	<0.01
VA tenure*	7.47	3.79	3.58	1.27	9.01	4.55	4.36	1.36	<0.01

Notes: RN = Registered Nurse, HPPD = Hours Per Patient Day, LPN = Licensed Practical Nurse, UAP = Unlicensed Assistive Personnel, BSN = Baccalaureate, *Weighted by the actual hours worked by each of these nurses during the month

Table 5.3 Correlation matrix of demeaned total (day and night) and night staffing and human capital variables

	1	2	3	4	5	6
Staffing						
1 Total HPPD						
2 Night HPPD	0.49***					
3 Total % HPPD provided by LPNs	0.19***	0.16***				
4 Night % HPPD provided by LPNs	-0.17***	0.01***	0.77***			
5 Total % HPPD provided by UAPs	0.01***	-0.06***	-0.38***	-0.24***		
6 Night % HPPD provided by UAPs	0.01***	0.07***	-0.31***	-0.16***	0.81***	
Education						
1 Total % Associate		2	3	4		
2 Night % Associate	0.77***					
3 Total % BSN	-0.56***	-0.47***				
4 Night % BSN	-0.45***	-0.58***	0.80***			
Experience						
1 Total Prior Experience		2	3	4	5	6
2 Night Prior Experience	0.80***					
3 Total Unit Tenure	-0.40***	-0.32***				
4 Night Unit Tenure	-0.29***	-0.34***	0.57***			
5 Total Facility Tenure	-0.48***	-0.39***	0.72***	0.51***		
6 Night Facility Tenure	-0.38***	-0.43***	0.58***	0.65***	0.80***	
7 Total VA Tenure	-0.55***	-0.47***	0.76***	0.51***	0.74***	0.62***
8 Night VA Tenure	-0.47***	-0.55***	0.62***	0.66***	0.62***	0.73***
0.83***						

Notes: *** = $p < 0.001$

Table 5.4 Monthly unit-level fixed effect regression estimates of demeaned total (day and night) and night staffing and human capital variables without education variables

		LOS		
		Coeff.	p value	95% Conf. Interval
Staffing	Total HPPD	-0.016	0.000	[-0.021, -0.010]
	Night HPPD	-0.034	0.000	[-0.046, -0.022]
	Total % HPPD provided by LPNs	0.068	0.960	[-0.072, 0.207]
	Night % HPPD provided by LPNs	-0.046	0.431	[-0.159, 0.068]
	Total % HPPD provided by UAPs	0.188	0.002	[0.069, 0.307]
	Night % HPPD provided by UAPs	0.050	0.500	[-0.095, 0.196]
Experience	Total Prior Experience	-0.001	0.905	[-0.012, 0.011]
	Night Prior Experience	-0.002	0.932	[-0.006, 0.006]
	Total Unit Tenure	-0.028	0.004	[-0.046, -0.009]
	Night Unit Tenure	-0.001	0.957	[-0.006, 0.006]
	Total Facility Tenure	0.002	0.710	[-0.010, 0.015]
	Night Facility Tenure	-0.001	0.788	[-0.009, 0.006]
	Total VA Tenure	0.004	0.506	[-0.007, 0.015]
	Night VA Tenure	-0.004	0.223	[-0.009, 0.002]

Notes: Model controls for % contract nurses, admissions, Elixhauser, DRGs (weighted in quantiles), age, and time dummies
LOS = Length of Stay, HPPD = Hours Per Patient Day, LPN = Licensed Practical Nurse, UAP = Unlicensed Assistive Personnel,
VA = Veterans' Affairs

Table 5.5 Monthly unit-level fixed effect regression estimates of demeaned total (day and night) and night staffing and human capital variables with education variables

		LOS		
		Coeff.	p value	95% Conf. Interval
Staffing	Total HPPD	-0.016	0.000	[-0.022, -0.011]
	Night HPPD	-0.033	0.000	[-0.046, -0.022]
	Total % HPPD provided by LPNs	0.064	0.367	[-0.075, 0.202]
	Night % HPPD provided by LPNs	-0.050	0.388	[-0.164, 0.064]
	Total % HPPD provided by UAPs	0.187	0.002	[0.070, 0.305]
	Night % HPPD provided by UAPs	0.046	0.543	[-0.102, 0.194]
Education	Total % Associate	-0.035	0.531	[-0.104, 0.074]
	Night % Associate	0.570	0.118	[-0.014, 0.128]
	Total % BSN	-0.034	0.579	[-0.155, 0.087]
	Night % BSN	-0.013	0.716	[-0.083, 0.057]
Experience	Total Prior Experience	-0.002	0.746	[-0.014, 0.010]
	Night Prior Experience	0.001	0.856	[-0.005, 0.006]
	Total Unit Tenure	-0.027	0.006	[-0.047, -0.008]
	Night Unit Tenure	-0.001	0.818	[-0.006, 0.005]
	Total Facility Tenure	0.003	0.654	[-0.009, 0.015]
	Night Facility Tenure	-0.001	0.731	[-0.009, 0.006]
	Total VA Tenure	0.004	0.495	[-0.007, 0.015]
	Night VA Tenure	-0.004	0.226	[-0.009, 0.002]

Notes: Model controls for % contract nurses, admissions, Elixhauser, DRGs (weighted in quantiles), age, and time dummies; LOS = Length of Stay, HPPD = Hours Per Patient Day, LPN = Licensed Practical Nurse, UAP = Unlicensed Assistive Personnel, BSN = Baccalaureate, VA = Veterans' Affairs

Chapter 6: Conclusions - Point of Interface

This purpose of this chapter is to conclude by summarizing the findings of this dissertation. The organization of this chapter begins with a synopsis of the systematic review and the limitations of the current state of the science. Then, following the methodology of Morse and Niehaus, the qualitative component is summarized and joined (*e.g.*, triangulate) with the quantitative results. A summary of the quantitative results is also discussed. The strengths and limitations of the entire dissertation are presented and this chapter ends with recommendations for practice, policy and topics for future research.

The majority of hospital care occurs beyond the traditional 9 - 5 Monday through Friday work week. The routine of 7 AM to 7 PM, Monday through Friday, is not representative of the environment in which most nursing work takes place (Hamilton, Mathur, Gemeinhardt, Eschiti, & Campbell, 2010). Studying off-shift nursing is a timely topic to better improve the quality and safety of patients.

Summary of Systematic Review

Many researchers have studied the occurrence of adverse patient safety events on off-shifts. Additionally, since healthcare providers deliver care 24 hours-a-day, 7 days-a-week, there are several studies examining the association of off-shifts and employee outcomes. Based on the findings of the systematic review, overall both patients and employees had worse outcomes on off-shifts than on more regular hours. However, there were limitations of the individual studies. For example, there was inconsistency on how off-shifts were operationalized and analyzed. Also, the sample patient population varied. Researchers that studied employees who worked off-shifts generally were limited to the use of weaker designs including small sample sizes and cross-sectional analyses, than those that studied patient quality outcome. Cross-sectional designs are a "snapshot" in time and causality cannot be inferred from these studies. However, unlike the quantitative outcome studies, the evidence was consistent that employees have worse outcomes at night because of fatigue and sleep disturbances, mental well being, and health related disturbances.

The existing evidence suggests that hospitals function less effectively on off-shifts (Bell & Redelmeir, 2001; Cram et al., 2004), however, there were only two studies that examined night nurse staffing and patient outcomes. Additionally, the underlying mechanism of why patient outcomes were worse off-shifts was still not understood. Based on the findings from the

systematic review, the implications for practice and policy is to understand what specifically happens on off-shifts that may impact quality care.

Addressing this gap in the evidence, the aim was to understand the relationships between nurse staffing and human capital on off-shifts and quality patient outcomes. To address this gap, mixed methods were used to study off-shift nursing. Although there is debate about the rigor of using mixed methods, this type of design maybe stronger than one that uses a single method. For example, mixed methods can enhance the validity of the project by enriching or expanding understanding or by verifying results from another perspective (Morse & Niehaus, 2009, p. 14). Morse and Niehaus' methodology was followed to first qualitatively understand off-shift nursing and then quantitatively test relationships of off-shift nursing and patient outcomes.

Summary of Qualitative Findings

The qualitative portion of the dissertation consisted of semi-structured interviews and observer-as-participant observations to explore off-shift nursing to understand of how quality care was maintained. Themes emerged about decreased resources, staffing, and experience on off-shifts. Specifically, at night, nurses expressed concern about decreased staffing of all personnel, but also commented about high levels of teamwork. Additionally, on both night shift and weekend shifts, nurses had to complete more tasks because they often did not have UAPs and/or ward clerks. Although, day nurses spoke positively about working weekends because they were able to "take a breath" and focus more on patient care.

Both day and night nurses commented about that newer nurses (*i.e.*, new graduate RNs and new nurses to the facility) were expected to work at night. However, nurses felt that at night, there was a mixture of RN personnel. According to the nurses, agency and traveler nurses worked the night shift because night shift most often had decreased staffing. Although new

nurses were expected to work nights, there was a core group of night nurses who worked nights for a number of years. All of the night nurses felt underappreciated for their work.

These themes of decreased resources are consistent with existing research. For example, in qualitative interviews of 38 critical care nurses, researchers found that support services and non-nurse staff are greatly diminished on off-shifts (Eschiti & Hamilton, 2010). However, because of the decreased resources on off-shifts, nurses seemed to adapt by increasing their teamwork, completing more tasks, and even taking time to "take a breath." What remains unclear and still needs to be explored is *how* and *if* these decreased resources negatively impact quality care.

Even after they were probed, nurses could not identify specific instances when patient care suffered because of decreased resources or staffing. However, completing more non-RN tasks may cause nurses to overlook important changes in patient's status and miss care. Kalish (2006) identified nine areas of missed care for patients including: ambulation, turning, delayed or missed feedings, patient teaching, discharge planning, emotional support, hygiene, intake and output documentation and surveillance. Some of the reasons for missed care included too few staff and poor use of existing staff resources (Kalisch, 2006). More recently, this team sampled 4,086 acute care nurses representing 10 hospitals and found that night shift workers reported significantly less missed care than day shift workers ($p < 0.01$) (Kalisch & Lee, 2011). These results are consistent with the findings from this dissertation in that off-shifts have less resources, however, nurses may have found ways despite the decreased resources and human capital to still provide quality care to patients.

Qualitative Findings Informed the Quantitative Analyses

Qualitative interviews and observations informed the quantitative analyses. Qualitative findings suggested that night shift and weekends were not identical entities. From the day perspective, nurses expressed "taking a breather" and generally, a slower pace, however, according to night nurses, this did not occur on weekend nights. For example, a Wednesday night shift was similar to a Saturday night shift. From this qualitative finding, the analyses were separated and focused on differences between "day" and "night." Weekend shifts were not quantitatively analyzed. Therefore, in future analyses, it may be interesting to examine weekend differences.

Summary of Quantitative Results

The quantitative study was guided by the theory of human capital. In this portion, a secondary analysis of an existing longitudinal dataset of VA patient and employee data inclusive of the years 2003 through 2006 was conducted. The purpose was to examine the effects of variations in total and night nursing inputs on length of stay in acute care units at VA hospitals. Nursing inputs included HPPD, percent of hours provided by LPN and UAPs, hours worked by associate and baccalaureate degree nurses, and years of experience. Nursing inputs were demeaned and fixed effects regressions were used to test the associations between staffing and human capital and LOS.

In the multivariable analyses, an independent effect of night staffing was found beyond the total staffing effect; this means night staffing is important. There was no independent effects of night skill mix or tenure. Additionally, when adding education variables to the model, the strength and significance of the coefficients did not change from the previous model.

Although descriptively, there were statistically significant differences between

characteristics of the nursing workforce during the day as compared to at night, these differences did not have a significant effect on LOS. These findings suggest that human capital at night does not necessarily need to be similar during the day to decrease LOS. However, increasing nurse human capital may improve patient safety and decrease other adverse events. The IOM Future of Nursing report recommends to increase educational preparation for the future of our profession (IOM Future of Nursing, 2010, p.12) and existing research suggests that higher education preparation decreases adverse patient outcomes, (Aiken et al., 2003; Kendall-Gallagher et al., 2011), therefore nurse administrators should consider all three nursing inputs (*i.e.*, staffing, education preparation, and experience) when developing off-shift staffing plans. More research on staffing including skill mix, education preparation, and experience on off-shifts is recommended.

Triangulation of Qualitative and Quantitative Findings

Qualitative findings and quantitative results were similar in terms of staffing levels of RN, LPN, and UAPs. Nurses expressed that personnel were decreased on the night shift as compared to during the day shift and in the quantitative results this was found.

Qualitative findings contextualized the quantitative results for night nurse experience. In this dissertation, 10 night nurses were interviewed. All of the night nurses except for one had greater than two years' experience. In fact, four of the nurses that were interviewed had over 15 years' experience. Therefore, a core group of experienced nurses worked at night. In the interviews, all nurses stated that new nurses were expected to work at night. Additionally, my observations reflected this theme. Nurses also commented new nurses would work the night shift for a year or two, until a day position was available. Then, the new nurse would "switch" to work during the day. Quantitatively, unit, facility, and VA tenure was higher at night. This can

be explained because a core group of experienced nurses at night would counterbalance the tenure of a nurse with one or two years' experience.

In the qualitative interviews and observations, there were decreased resources at night. Nurses who were interviewed emphasized that staffing was decreased at night compared to during the day. However, nurses did not state that the decreased staffing at night was detrimental to patients. This is not congruent with the quantitative regressions that night staffing had a large effect on LOS. Therefore as night staffing decreased, LOS increased. While the night nurses did not perceive that they provided lower quality of care, this finding can be explained by their interviews. Despite the decreased resources, nurses perceived that the quality care was maintained by the collaboration of night nurses and increasing tasks. For example, nurses were required to complete more tasks at night than during the day to ensure patient safety. Completing more tasks may increase nurse workload and responsibility. Increased workload at night may overflow to dayshift responsibilities which may delay patients' discharges and as a result, increase LOS. Further exploration of how nurses ensure patient safety at night despite decreased staffing levels are recommended

Strengths of the Dissertation

There were several strengths of the dissertation. In the systematic review, 54 healthcare studies and 14 non-healthcare studies were reviewed. The non-healthcare studies are available in Appendix A. The search was conducted over several months resulting in a large body of evidence. The studies were critiqued systematically with a study appraisal guide. Although synthesizing the evidence was challenging because of diverse samples, definition of off-shifts, and outcomes, the review was comprehensive including studies that pertained both to quality and

employee outcomes. Furthermore to my knowledge, this was the first review of the off-shift literature.

Using a mixed methods approach was another strength in the dissertation. Following a strict, accepted methodology by highly regarded researchers, using mixed methods allowed me to gain understanding about off-shift nursing that would not have occurred by conducting only the quantitative analyses. The quantitative results were triangulated with the qualitative findings and followed the methodology strictly ensuring that qualitative study was conducted with enough credibility and dependability to exist separately.

The ability to use a large, unique longitudinal dataset was another strength of this dissertation. Previous researchers have been limited to cross-sectional analyses because of the decreased availability of longitudinal data. Additionally, data were analyzed at the unit-level, as opposed to the hospital-level, which allowed me to summarize LOS by types of units. As previously discussed, there were limitations in conducting the unit-level analyses, however, using unit-level data was stronger than hospital-level aggregated data.

Limitations of the Dissertation

In addition to strengths, there were some limitations to this dissertation. With the systematic review, a thorough search of the databases was conducted as well as an examination of reference lists, however, it was possible that some studies were missed. Additionally, although the studies were appraised for quality, there was no attempt to numerically grade the studies because of the diversity of samples, study designs, and outcomes. Due to page limitations of journals, the non-healthcare studies were not included. As previously mentioned, these studies are available to the reader in Appendix A. In the future, the search on the non-

healthcare literature will be expanded and these findings will be submitted to a journal titled *The Open Occupational Health & Safety Journal*.

There were also limitations in the qualitative portion of this dissertation. Nurses who worked fixed shifts were interviewed and they did not rotate between shifts. Based on the evidence in the systematic review, this lack of rotation between shifts was beneficial by decreasing fatigue and increasing job satisfaction. However, nurse perceptions were sometimes dichotomized between "day" and "night". For example, night nurses felt under-appreciated from their day colleagues whereas day nurses did not express that night work was less important. Upon review, it may have strengthened these findings by interviewing nurses who rotated between shifts to further probe about these perceptions. Nurses were not asked about their educational preparation which would have strengthened the triangulation of findings between the qualitative and the quantitative components.

In the quantitative portion, it was hypothesized that less staffing, less educated, and less experienced nurses worked at night would impact patient outcomes. However, there still some variables that could have strengthened the analysis. For example, data including physicians and other ancillary personnel were not available. Additionally, less supervision or higher levels of fatigue at night may also be related to poor patient outcomes and these variables were also not available. Finally, these results are limited because they are mostly generalizable to VA hospitals.

Summary of Practice Recommendations

Based on the overall findings of this dissertation, nurse administrators should consider all three nursing inputs (*i.e.*, staffing, educational preparation, and experience) when developing night staffing plans. Nighttime staffing of all nursing personnel should be similar to daytime

staffing to ensure quality care. Differences in staffing levels at night as compared to during the day may exacerbate night nurses' perceptions of decreased resources available to them.

Administrators should also encourage communication between both day and night nurses to alleviate any feelings of under-appreciation. Finally, investing in off-shift engagement activities may help night nurses to feel more appreciated and may also aid in increasing nurse retention.

Summary of Policy Recommendations

The IOM's Future of Nursing Report recommends that nurses achieve higher educational preparation to meet the demands of an evolving healthcare system (Initiative on the Future of Nursing, 2010, p.41). Additionally, nurses in hospitals are required to make critical decisions for sicker patients and work with sophisticated, life-saving technology (Initiative on the Future of Nursing, 2010). When tenure is high, the quantitative findings suggest that education does not necessarily need to be similar across day and night shifts. Therefore, policies that address both education and experience (*e.g.*, excluding current experienced nurses from an educational mandate) are recommended.

The Registered Nurse Safe Staffing Act of 2011 (S.58/ H.R. 876) empowers nurses to inform administrators through staffing committees on developing appropriate staffing plans (ANA, 2011). As a result, seven states have already passed safe staffing laws based on this act (ANA, 2011). Based on the findings of this dissertation, legislation such as this is recommended as opposed to static mandated staffing ratios.

Future Research Recommendations

There are several future research opportunities to continue to study off-shifts and quality care. First, studying characteristics of off-shifts that may impact patient safety is recommended. Further understanding of what specifically occurs (*e.g.*, decreased staffing, fatigued providers,

less experienced staff) may expand the off-shift evidence. Researchers could then use other types of study designs, such as interventional studies, to address how to improve these potential occurrences.

The influence of decreased resources and human capital on off-shifts should also be further qualitatively examined. Although other qualitative researchers have found that there are decreased resources on off-shifts, delving further and asking nurses for specific examples on how decreased resources impacts patient safety should be explored. Additionally, in the qualitative portion of the dissertation, the study was conducted in two hospitals, a VA and a non-VA setting. Although these hospitals shared similarities in that they were both teaching institutions and geographically near/in urban settings, interviewing nurses in only two hospitals limits the transferability of the findings. Future qualitative work with other nurses in different hospitals is recommended.

Additional quantitative considerations for future research include using this VA dataset with patient-level analyses as well as including additional personnel types (*e.g.*, physicians and ward clerks). As mentioned above, this VA dataset is both comprehensive and unique, however, it is limited because the results are mostly generalizable to VA settings. For example, there were some differences between VA settings and non-VA settings as expressed in the qualitative interviews. In the VA setting, nurses stated that agency nurses are often former VA nurses. Additionally, managers shared that they do not follow the nurse-to-patient ratio as compared to other non-Federal hospitals. These differences that exist between VA and non-VA hospitals may further impact the generalizability of these findings to non-VA hospitals. Therefore, encouraging researchers to use unit-level, non-VA data would enhance the state of the science

Conclusion

To our knowledge, this is the first study that qualitatively and quantitatively studied staffing and human capital on off-shifts. Nurses will continue to work 24 hours, 7 days-a-week in hospitals. Additionally, patient safety will continue to be a topic of utmost importance for researchers, policy makers, administrators, health providers, and consumers. Given the abundance of evidence suggesting that off-shifts are associated with poor quality outcomes, it behooves the research community to continue to investigate the specific factors relating to off-shifts that may impact patient care. Further knowledge may inform ways that can improve both the quality of the provider as well as the care of the patient.

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List of AppendicesAppendix A, Chapter 2

Non-healthcare Quality and Employee Outcome Studies

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Appendix B, Chapter 4

Interview Guide Text and Guide

Themes of Off-shift Nursing Work

Appendix C, Chapter 5

Overview of Concepts, Variables, and Data Source(s)

Correlation Matrix of Total (Day and Night) and Night Staffing and Human Capital Variables

Power Analysis Explanation

Appendix A, Chapter 2

Non-healthcare Quality and Employee Outcome Studies

There were 12 quantitative studies found examining quality and employee outcomes in non-healthcare environments (Arditi, Ayrancioglu, & Shi, 2005; Baker, Roach, Ferguson, & Dawson, 2004; Bonnefond et al., 2001; Demerouti, Geurts, Bakker, & Euwema, 2004; Garbarino et al., 2002; Gillberg, Kecklund, Goransson, & Akerstedt, 2003; Lac & Chamoux, 2004; Nag & Nag, 2004; Rouch, Wild, Ansiau, & Marquie, 2005; Smith et al., 2005; Takahashi et al., 2005; Zhu, Hjollund, & Olsen, 2004). In 41% of the studies, off-shifts were defined as nights ($n = 5$). These studies examined a variety of employees including construction workers, power plant operators, and police officers. The sample sizes ranged from 12 to 3,237 employees. Although the majority of researchers used cross-sectional designs, two studies used interventional strategies. For example, one investigative team tested napping as an intervention to decrease shift work-related sleepiness. These researchers found a statistically significant effect that a short rest period during night shift had a positive effect on vigilance level (Bonnefond et al., 2001). In another study, researchers measured reaction time and errors on a production simulator for power plant operators who worked during the day compared to power plant operators who worked at night (Gillberg et al., 2003). These researchers found that the reaction time and the number of errors committed did not differ between shifts (Gillberg et al., 2003).

The remaining ($n = 7$) non-healthcare studies, researchers examined nights with rotation (Baker et al., 2004; Demerouti et al., 2004; Lac & Chamoux, 2004; Nag & Nag, 2004; Smith et al., 2005; Takahashi et al., 2005; Zhu et al., 2004). Employees sampled included nuclear power plant operators, food production workers, telephone operators, and military police. The sample

sizes in these studies were generally larger (range 32 - 54, 954) than the sample sizes of both the non-healthcare night studies and the healthcare nights with rotation studies. One research team used a database registry with a longitudinal design (Zhu et al., 2004). Similar to the healthcare employee literature, researchers studied sleep and health outcomes. Three research groups found that employees who rotated to nights were more likely to have sleep disturbances and poorer health (Demerouti et al., 2004; Lac & Chamoux, 2004; Nag & Nag, 2004). Additionally, 71% (n = 5) of the studies examined employee level of control over scheduling and preferred working time. These researchers found that if employees had control over their schedule, they were less likely to report poor sleep quality, high stress, and high family/social conflict (Lac & Chamoux, 2004; Smith et al., 2005; Takahashi et al., 2005).

Appendix A, Table 1. Non-healthcare studies examining off-shifts and quality and employee outcomes						
Author (s), Year	Sample	Sample Size	Multisite (# of sites)	Outcome(s)	Increased risk for poor outcomes	
Nights						
Arditi et al., 2005	Construction workers	27	N	Accidents	N	
Rouch et al., 2005	Multiple professions Control room thermal power plant operators	3,237	Y	Cognitive efficiency, sleep disturbances	Y	
Gillberg et al., 2003	Police	12	N	Errors, reaction time, sleepiness	Mixed	
Garabarino et al., 2002	Electrical power plant operators	1,840	N	Sleep quality, insomnia	Mixed	
Bonnefond et al., 2001		12	N	Sleep quality, mood	N	
Nights with rotation						
Smith et al., 2005	Nuclear power plant operators	613	Y (3)	Sleep quality, control, health, family and social conflict, money	Mixed	
Takahasi et al., 2005	Nuclear power plant operators	608	Y ^a	Adaptation, control	Mixed	
Baker et al., 2004	Multiple professions	763	Y	Preferred working time	NA ^b	
Lac & Chamoux, 2004	Food production workers	32	N	Sleep quantity, health, control, job satisfaction, stress, heart rate	Y	
Nag & Nag, 2004	Telephone operators	136	Y ^c	Health, well-being, sleep	Y	
Demerouti et al., 2004	Military police	3,122	Y ^d	Burnout, health, satisfaction	Y	
Zhu et al., 2004	Pregnant shift workers	54,954	Registry	Gestational age, birth weight	Mixed	
Notes: Y = Yes, N = No, NA = Not Applicable,						
^a Convenience sample in which questionnaires were distributed by managers						
^b Purpose of study was to identify if preference of working shifts differed by age and experience						
^c Convenience sample						
^d Random sample of 3,122 military police						
All study designs were cross-sectional except for Bonnefond et al., Gillberg et al., and Zhu et al.						

Appendix A, Chapter 2

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19-Apr-2011

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Please attend to the following issues:

1. Please refer to the JAN author guidelines (see JAN website) for reporting reviews. Please follow these guidelines exactly. Use the headings and subheadings as they appear in the guidance.

At present the manuscript has not made the full transition from a report to a journal article and is currently 89 pages long (mainly a long appendix) , which will translate to well over 100 pages in the print journal (see point 5 for a solution).

2. Draw out the emphasis for nursing and cross check that nursing is included as a key word.

3. The referee is concerned that important key literature has not been located and included.

Please revisit the search strategy and update the review if new evidence is located.

4. At present quality appraisal of quantitative evidence appears to be in part combined with data abstraction/extraction of evidence? The 'tool' outlining the quality criteria appears to have been produced in house. How was this development of this 'tool' undertaken and piloted? Why not use a selection of the validated appraisal tools appropriate to study-type? No appraisal of qualitative evidence using appears to have been undertaken using an appropriate appraisal tool. For a systematic review following CRD guidelines quality appraisal using appropriate quality appraisal tools is essential. Please look again at this aspect of the review. Quality appraisal is also usually undertaken by more than one person.

5. At present the manuscript is 89 pages long and not suitable for a print journal. Please see the JAN author guidelines for reporting reviews and make use of the supplemental file facility. If including additional web-based material - please make sure that the paper version of the print journal contains all the required data to comply with PRISMA reporting standards as data contained in web files is not accessible from the print version.

6. Please revisit the abstract. Make sure the review design is stated (mixed-method SR) and include the dates for which databases were searched. The results and conclusion could be more specific. It is insufficient to generally talk about strong evidence. Quantitative evidence is statistically significant or not and should match with evidence reported in the main manuscript such as p values, odds ratios or relative risks (etc), with as appropriate evidence of precision such as confidence intervals.

7. Off shift is also referred to as 'out of hours' care. Please make clear the equivalent international definitions.

8. Please refer to the JAN author guidance for concluding the manuscript. Include implications for nursing - what should nurses/healthcare professionals take from this review and what should they do about it to improve patient outcomes and professionals' shift experience?

Thank you once again for submitting your review. I look forward to receiving your revised manuscript.

REVIEWER COMMENTS:

Reviewer: 1

Comments to the Author

The theme is relevant, it is welcome a review on this matter, but I did not find a lot of important literature in the occupational health area. Probably the authors did not know the Working Time Society, a committee of the International Commission on Occupational Health (ICOH) which promotes research on shift work and other working time arrangements and aspects on health, safety and well-being. The results of its different meetings are reported in some volumes of Chronobiology International. Perhaps could be sufficient add other names were are reported those of Rosa & Colligan as Costa G., Camerino D. or others. (Editor note: the referee is referring to known studies that have not been identified or included).

There are some errors in the text :

heat conditions instead of health condition

to help interpret instead of to help interpretation

was adapted instead of was adopted

Appendix B, Chapter 4

Interview Guide with Text

The interview guide was prepared where questions were formulated in a logical, chronological order (Morse & Field, 2002, p. 76). The guide was constructed with three sections to guide the conversation from nurse staffing, to nurse human capital, and then to the delivery of patient care. All three sections pertain to the shift in which the nurse works. The headings in the three sections were guided by human capital theory and preliminary work by the mentoring team. There are two types of human capital - general and specific. General human capital involves overall education and experience level, whereas specific human capital involves experience and skills specific to a hospital or even a nursing unit. Questions about nurse experience were developed based on this theory.

Nurse Manager Interview Questions

The purpose of this interview is to learn more about off-shift nursing from the perspective of two nurse managers. The nurse managers that will be interviewed include; 1) a nurse manager of an acute care unit, and 2) a nurse manager of an intensive care unit. The interview is divided into three major sections. The first section focuses on how the nurse manager determines staffing levels on the off-shifts. The second section focuses on the experience level of the nurse. The third section focuses on how the nurse manager ensures that quality care and patient safety is maintained on the off-shifts.

Stress importance of study, responses are invaluable, and all answers are de-identified and confidential

- Demographics
 - How long have you been a nurse?
 - How long have you worked at this hospital?
 - How long have you been a nurse manager?
 - How long have you been a nurse manager of this unit?
 - Did you work on this unit as a staff nurse?

Staffing on off-shifts

The purpose of these questions in this section is to learn about staffing; specifically how staffing is determined and maintained on the off-shifts. We are interested to learn about the organization of staff on the off-shifts (*i.e.*, numbers of unlicensed assistive personnel and presence of a charge nurse). Finally, we are interested to learn about the nurse manager's perception of nurse staffing and how it may relate to patient care.

- Staffing
 - What is the nurse to patient ratio for your unit? Does it differ at night?
 - What happens when a nurse calls out sick?
 - Talk to me about staffing nursing assistants and unit secretaries, how are these roles incorporated into your staffing on all shifts?
 - When hiring nurses, how do you fill night positions?

- Can you tell me about the shift scheduling process and how you assign nurses to work specific shifts? Are there any challenges that you face when making the schedule?

Experience level of nurses on off-shifts

The purpose of these questions in this section is to learn about the experience level of the nurse who works the off-shifts. We are interested in firm-specific and unit-specific knowledge and skills that are required for nurses to perform successfully in their jobs. Additionally, we are also interested in how nurses work in teams.

- General Human Capital
 - Overall, are there differences in experience level for nurses who work the day shift as compared to night shift? If no, how do you ensure that all shifts have similar experience levels?
 - What is the average years of experience that work on your unit?
- Firm-Specific and Unit-Specific Human Capital
 - Can you tell me about nurse orientation?
 - Can you tell me about continuing education modules, introduction of new technologies (*i.e.*, a new IV pump), and new protocols and when that training occurs?
 - Tell me about “floating”? How is that decision made if a nurse needs to float?
 - How do nurses on your unit work in teams?

Quality care and patient safety on off-shifts

The purpose of these questions in this section is to learn how quality care and patient safety is maintained on the off-shifts. We are interested if there are any differences in quality care that occur between nurses working off-shifts as compared to nurses working more regular hours.

- Quality care and patient safety
 - How do your nurses ensure patient safety?

- What departments are available to nurses who work the off-shifts? (*i.e.*, pharmacy, nutrition, physical/occupational therapy, transport, wound care)?
- Can you tell me about how a nurse would get in contact with the patient's physician specifically on the night shift or a weekend?

- Potential differences in quality between regular hours and off-shifts
 - Have you heard of any differences, if any, in the type of care that is delivered on nights and weekends as compared to day hours?
 - In your expertise, is night care similar or different to weekend care?
 - Are there any times in which a nurse, or any member of your staff, commented to you about differences between nights and days?
 - Have you heard of a patient that has commented to you about differences between nights and days?

Conclusion:

Is there anything else that you would like to talk about?

Staff Nurse Interview Questions

The purpose of interview is to learn more about off-shift nursing from the perspective of eight staff nurses who work different shifts. Four of the nurses will be from acute care units and the other four nurses will be from intensive care units. The nurses that will be interviewed include; 1) a nurse that works permanent day shifts and 2) a nurse that works permanent night shifts. The interview is divided into three major sections. The first section focuses on how the staff nurse's perception of nurse staffing. The second section focuses on the staff nurse's experience level. The third section focuses on how the staff nurse ensures quality care and patient safety on the shift that the nurse works.

Stress importance of study, responses are invaluable, and confidentiality

- Demographics
 - How long have you been a nurse?
 - How long have you worked at this hospital?
 - How long have you worked on this unit? Have you worked on different units within this hospital?

Staffing

The purpose of questions in this section is to learn about the how staff nurses view staffing levels on the shift that they work. We are interested to learn if staffing levels change between shifts, and if so, does that change have an effect on patient care.

- Shifts
 - Tell me about a typical shift?
 - Why do you work the shift that you do?
 - Have you ever worked a different shift? If so, why did you switch?
 - Tell me about any differences that may exist from your shift compared to other shifts?
 - Are there any experiences in which other nurses or other staff commented to you about differences between shifts? Have any patients ever commented to you about differences between shifts?
 - (*Nights RNs only*) Some people feel that nights and weekends are similar in the terms of staffing and resources, how do you feel about that?
- Staffing

- Can you tell me about nurse staffing?
- How are sick calls covered?
- Can you tell me what happens if you are short-staffed.

Experience level of nurses on off-shifts

The purpose of questions in this section is to learn about the experience level of the staff nurse. We are interested in the general experience level. We are also interested in firm-specific (hospital) and unit-specific experience and skills that are required for nurses to perform successfully in their jobs. Additionally, we want to find out about how nurses perceive working in teams.

- General Human Capital:
 - How have your years of experience as an RN influence the work that you do?
- Firm-Specific, Unit-Specific Human Capital, Team Specific:
 - Can you tell me about orientation?
 - Can you tell me about how new protocols, in-services, or additional training are offered?
 - Can you tell me about floating?
 - How do you work as a team?
 - How do you feel about the experience level of the nurses that you work with?
 - Does the amount of work change depending on the nursing team that you are working with?

Quality care and patient safety on off-shifts

The purpose of questions in this section is to learn how a staff nurse delivers quality care and maintains patient safety on the shift that the nurse works.

- Quality care and patient safety

- How do you ensure patient safety on your shift?
- Can you tell me what departments are available to you during your shift?
- Can you tell me how do you get in contact with the patient's physician?
- Specifically on your shift, do you have all the necessary tools to deliver safe patient care?
- Tell me about shift-to-shift report/handoff process?
- How do you feel about the work that you do as nurse?

Conclusion:

Is there anything else that you would like to talk about?

Appendix B, Table 1. Themes of off-shift nursing work	
Decreased resources	Collaboration among self-reliant night nurses Increasing tasks Taking a breather on weekend day shift
Decreased human capital	Rite of passage expectation for new nurses Mixture of RN personnel Night nurse perception of under-appreciation

Appendix C, Table 1. Overview of concepts, variables, and data source		
CONCEPT	VARIABLE	DATA SOURCE(S)
Patient Attributes		
Demographics	Age	Patient Discharge Abstract
Severity of illness	DRG case-mix weights	Patient Discharge Abstract and MDS
Co-morbidities	Elixhauser index	Patient Discharge Abstract
Unit and Facility Attributes		
Unit Characteristics	Type (ICU and Acute Care)	DSS IPD/Ward
	Patient volume indicated by number of admissions	DSS IPD/Ward, ALBHR, ALBCC
Nursing Inputs*		
Staffing	Total RN hours with direct patient care responsibility per patient day Total LPN hours with direct patient care responsibility per patient day Total UAP hours with direct patient care responsibility per patient day	ALBHR, ALBCC (hours), DSS IPD/Ward (patient days) and PAID
General Human Capital	Education and enhanced qualifications of RNs, LPNs and UAPs	PAID
	Experience	PAID
	Skill mix	ALBHR and ALBCC
Facility-Specific and Unit-Specific Human Capital	Tenure of RNs in facility Tenure of RNs on unit	ALBCCC and PAID
Outcome		
Length of Stay	Number of hospital days	DSS IPD/Ward
<p>Notes: DRG = Diagnosis related group, MDS = minimum dataset, AHA = Annual Survey of Hospitals, ALBHR = Account Level Budgeter Hours, ALBCC = Account Level Budgeter Cost Center, DSS IPD/Ward = Decision support system Intermediate Product Detail and Ward files, PAID = payroll data, ICD = International Classification of Diseases, RN = Registered Nurses, LPN = Licensed Practical Nurses, UAP = Unlicensed Assistive Personnel</p> <p>*Each nursing input was calculated as a total unit-monthly average. For each nursing input, an off-shifts differential was created.</p>		

Appendix C, Table 2. Correlation matrix of total (day and night) and night staffing and human capital variables

	1	2	3	4	5	6
Staffing						
1 Total HPPD						
2 Night HPPD	0.97***					
3 Total % HPPD provided by LPNs	-0.16***	-0.17***				
4 Night % HPPD provided by LPNs	0.02***	0.04***	0.74***			
5 Total % HPPD provided by UAPs	-0.06***	-0.05***	-0.38***	-0.24***		
6 Night % HPPD provided by UAPs	0.10***	0.09***	-0.31***	-0.11***	0.81***	
Education						
1 Total % Associate						
2 Night % Associate	0.77***					
3 Total % BSN	-0.56***	-0.47***				
4 Night % BSN	-0.45***	-0.59***	0.80***			
Experience						
1 Total Prior Experience						
2 Night Prior Experience	0.80***					
3 Total Unit Tenure	-0.37***	-0.30***				
4 Night Unit Tenure	-0.29***	-0.34***	0.57***			
5 Total Facility Tenure	-0.46***	-0.38***	0.73***	0.51***		
6 Night Facility Tenure	-0.37***	-0.42***	0.58***	0.65***	0.81***	
7 Total VA Tenure	-0.55***	-0.48***	0.76***	0.52***	0.73***	0.60***
8 Night VA Tenure	-0.47***	-0.55***	0.62***	0.66***	0.60***	0.72***
Notes: *** = $p < 0.001$						

Power Analysis Explanation

Based on preliminary research, there was adequate statistical power for this study. The current 48-month sample had data from observations included 185 acute care units and 130 ICUs at 126 facilities. Instead of a power calculation, we used the data from previous analyses to determine our ability to detect various types of changes in the 4-year sample. From the results of previous studies, there was the power to detect fairly small effects in nurse staffing and human capital. Specifically, they had 95% power to detect changes. For example, a one hour increase in HPPD reduced LOS by one percent. With the composite PSIs, they had 95% power to detect a 2% change in the ICUs. For this study, we estimated the effect of differences in the off-shift/regular shift nurse staffing and human capital variables, while controlling for the overall staffing and human capital. Only two previous studies were found that estimated effects of nurse staffing on night shifts and patient outcomes (Amaravadi et al. 2000, Dimick et al.2001). In both of these studies, researchers found when there were moderate decreases in nurse staffing at night (*i.e.*, moderate effect sizes), there were increased LOS and mortality with effect sizes much larger than the ones we have power to detect (*e.g.*, odds ratios >2.0).