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Difference in Recommended-To-Actual Nurse Staffing and Patient Falls

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ABSTRACT

Patient falls are a serious safety concern in hospitals. Injuries from falls can be devastating to patients and are now subject to reimbursement penalties from the Center for Medicare and Medicaid Services. Patient falls have been identified by the American Nurses Association as a nursing sensitive indictor suggesting that improvements in the quality or quantity of nurses may impact this outcome. Moreover, the literature suggests that nurse staffing levels have an impact on various patient outcomes such as patient falls. Therefore, identifying appropriate nurse staffing levels to minimize patient falls is critically important to hospitals.

A variety of staffing metrics have been used to examine nurse staffing levels, however, they are often criticized because of the level of measurement. This study utilized a novel measure that examined the difference between recommended staffing and actual staffing levels, at the shift level, and its association with patient falls. The resource-based view of the firm served as the conceptual framework. The hypotheses for this study posited that differences between recommended-to-actual staffing differences will increase the likelihood of patient falls. More specifically, understaffing will increase the likelihood of patient falls. Two hospitals within a large health system in the Midwest served as the study sites, and all staffing and patient fall data were obtained from these organizations. Results demonstrated no statistical significance between understaffing, and patient falls when measured at the shift level. This study is the first to examine nurse staffing and patient falls using the recommended-to-actual staffing metric at the shift

level. As such, it provides a foundation on which subsequent research can be built. Additionally, nurses and nurse leaders may want to consider alternative interventions to reduce patient falls.

Keywords: nurse staffing, patient falls, nursing sensitive indicators, nursing staffing and patient outcomes, resource-based view of the firm

DEDICATION

This research is dedicated to the boundless efforts of nurses and nurse leaders who struggle to balance the ever-increasing demands of patient care with safe and responsible nurse staffing.

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AHRQ	Agency for Healthcare Research and Quality
ANA	American Nurses Association
CAUTI	Catheter associated urinary tract infections
CMS	Centers for Medicare and Medicaid Services
DRAS	Difference in recommended-to-actual staffing
FTE	Full-time equivalent
FTR	Failure to rescue
FOG	Freezing of gait
HAC	Hospital acquired condition
HPPD	Hours per patient day
LOS	Length of stay
LPN	Licensed Practical Nurse
NDNQI	National Database of Nursing Quality Indicators
NSI	Nursing sensitive indicator
NT	Nurse Technician
NT HPPD	Nurse Technician hours per patient day
NT-DRAS	Nurse Technician – difference in recommended-to-actual staffing
PD	Parkinson’s disease
PSI	Patient safety indicator
QINS	Quality Improvement Nurse Specialist

RN	Registered Nurse
RN-DRAS	Registered Nurse-difference in recommended-to-actual staffing
RN HPPD	Registered Nurse hours per patient day
T-DRAS	Total – difference between recommended-to-actual staffing
THPPD	Total hours per patient day
TKA	Total knee arthroscopy

CHAPTER 1

Introduction

Statement of the Problem

In the United States, as many as one million patients fall in hospitals each year, and approximately half of those falls result in injury (Agency for Healthcare Research and Quality, August, 2013). Overall, falls are the leading cause of fatal and non-fatal injuries among older adults in all settings. Age-adjusted fall fatalities have doubled from 2000 to 2013 in adults greater than 65 years of age (Kramarow, Chen, Hedegaard, & Warner, 2015). One of every three individuals over the age of 65 who is living in the community and as many as one of every two residents of long-term care facilities falls each year (O'Loughlin, Robitaille, Boivin, & Suissa, 1993; Rubenstein, Josephson, & Robbins, 1994; Stevens, Mack, Paulozzi, & Ballesteros, 2008).

Two of the most devastating fall injuries are traumatic brain injuries and hip fractures. In 2005, there were 7,946 fall-related traumatic brain injury deaths and another 56,423 non-fatal traumatic brain injuries in people over 65 years of age (Thomas, Stevens, Sarmiento, & Wald, 2008). In 2010, 258,000 patients were discharged from the hospital with a diagnosis of hip fracture and 95% of these diagnoses were related to a fall (National Hospital Discharge Survey; Parkkari et al., 1999). These injuries often lead to a loss of independence, decreased mobility, fear of falling, and increased mortality. Among patients who sustain a hip fracture while hospitalized, there is a 47% increase in mortality within 12 months of the injury (Johal, Boulton, & Moran, 2009).

Costs to the United States healthcare system for fall-related care are staggering as well, with over $19 billion spent in 2000; these costs were estimated to be $23.6 billion in 2005 dollars (Center for Disease Control and Prevention, 2005a). Individual patient costs can be as high as $19,440 per fall episode considering emergency room visits, hospitalization, and post-acute follow-up (Rizzo et al., 1998). For patients who fall in hospitals, length of stay increases and costs are $4,233 higher (Bates, Pruess, Souney, & Platt, 1995).

As part of the Deficit Reduction Act of 2005, patient falls became one of several patient outcomes identified by the Centers for Medicare and Medicaid Services (CMS) as a hospital acquired condition (HAC) contributing to increases in length of stay (LOS) and cost (www.CMS.gov). As a result, complications related to a fall, such as a fracture or other injury, cannot be classified into a higher diagnostic related group (DRG) through the inpatient prospective payment system. Care provided to the patient to treat the injury is therefore uncompensated.

Patient falls in hospitals are categorized by the American Nurses Association (ANA) as a nursing sensitive indicator, suggesting that the outcome is impacted by the structures and processes of care provided by nurses (Appendix A) (www.nursingworld.org). Structure embodies four elements of nurse staffing: staffing levels, skill set of the nurses, education, and certification. Process refers to the actual nursing care provided and includes patient assessment and interventions. Citing guidance from the American Nursing Association, Yoder-Wise (2013) stated: “Patient outcomes that are determined to be nursing sensitive are those that improve if there is a greater quantity or quality of nursing care” (p. 399). This definition resonates with staff nurses who often voice frustration with having insufficient time to provide quality care. When reductions in staff occur in hospitals, nurses' workloads increase. Combined with higher patient acuity, increased documentation requirements, and new technology, these factors burden the staff (Furukawa, Raghu, & Shao, 2010; Weinstein et al., 1999). The position of many professional nursing associations as well as organized labor unions is that more nurses at the bedside contribute to better patient outcomes. This sentiment is corroborated by numerous researchers who have evaluated the association between nurse staffing and various patient outcomes and determined that increased levels of nurse staffing are associated with better patient outcomes (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Cho, Hwang, & Kim, 2008; Needleman et al., 2011).

Yet, research studies that have specifically examined the association between nurse staffing levels in hospitals and patient falls have demonstrated mixed results (Blegen, Goode, & Reed, 1998; Blegen & Vaughn, 1998; Cho, Ketefian, Barkauskas, & Smith, 2003; Donaldson et al., 2005; Dunton, Gajewski, Taunton, & Moore, 2004; Everhart et al., 2014; Hall, Doran, & Pink, 2004; Kovner & Gergen, 1998; Lake & Cheung, 2006; Lang, Hodge, Olson, Romano, & Kravitz, 2004; Langemo, Anderson, & Volden, 2002; Oliver, Daly, Martin, & McMurdo, 2004; Sovie & Jawad, 2001). Mick and Mark (2005) postulated that the lack of standard definitions of staffing, inconsistencies in methodological and conceptual design, and the absence of theory-driven studies contributes to these equivocal results.

More recently, scholars have suggested that mixed results may be due to research that aggregates staffing characteristics to the organizational level, potentially masking unique unit and shift level detail (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Lake & Cheung, 2006). To address the concern of aggregated data, shift level data have been utilized to examine the association between nurse staffing and falls. Results demonstrated that increased nursing care hours were significantly associated with reduced patient falls (Patrician et al., 2011). Using a portion of the same database but aggregating data at the unit level, researchers found no association between the total number of nursing care hours and patient falls (Breckenridge-Sproat, Johantgen, & Patrician, 2012). The findings from this most current study suggest that shift level data are more appropriate for examining relationships between nurse staffing and patient outcomes.

Expanding on the use of shift level data, researchers evaluated inpatient mortality as a function of the number of shifts that a patient was exposed to Registered Nurse (RN) hours of care that fell below target by eight hours or greater (Needleman et al., 2011). Target hours were derived from a commercially available patient classification system that considers patient care needs based on acuity. Study findings demonstrated a significant association between inpatient mortality and the number of shifts in which RN staffing levels were eight hours or greater below target. One explanation of these findings is that when recommended staffing levels are not achieved, there is less frequent patient monitoring and more missed nursing care interventions, which can potentially lead to adverse patient outcomes. This particular type of analysis, however, has not been performed for patient falls.

Purpose of the Study

The purpose of this study was to examine differences in recommended-to-actual nursing care hours and its association with patient falls in an acute care hospital setting. Specifically, the study addressed the following research questions:

1. What percentage of shifts were staffed below-target nursing care hours?
2. What is the relationship between patient falls in an acute care hospital and the difference in recommended-to-actual total nursing care hours?
3. What is the relationship between patient falls in an acute care hospital and the difference in recommended-to-actual RN nursing care hours?
4. What is the relationship between patient falls in an acute care hospital and the difference in recommended-to-actual nurse technician nursing care hours?

This study expands previous research by utilizing shift-level staffing instead of hospital or unit-level staffing measures (Needleman et al., 2011; Patrician et al., 2011). Likewise, it extends Needleman's work by using a continuous variable of differences between recommended and actual nursing hours as the independent variable (Needleman, Kurtzman, & Kizer, 2007). Donabedian's quality outcome model served as the organizational framework while the resource-based theory of the firm provided the theoretical framework to develop the hypotheses.

Significance of the Study

For the last two decades, research examining the association between nurse staffing and patient outcomes has demonstrated mixed results. Consequently, there is a need for further research that can account for these conflicting relationships. A better understanding of what is driving such conflicting relationships, and more generally, the relationship between nurse staffing and patient outcomes in hospitals is important as continued degradation of reimbursement often results in staff reductions that can be detrimental to patient safety. These staff reductions can be detrimental to patient safety. The interest in achieving positive patient outcomes is magnified by the fact that reimbursement is now associated with these outcomes. Therefore, the findings of the study are likely to be of interest to a number of stakeholders.

Hospital administrators need to know how variations affect quality so they can allocate resources effectively and efficiently. Variations that negatively affect quality may negatively affect reimbursement, and longer term, variations may negatively influence the hospital's reputation. Patients and families may also be interested in understanding how variations affect patient falls because poor quality/adverse events such as falls directly affect their quality of life. Additionally, physicians, nurses, and other clinical staff members may be interested in the findings of this study because they are on the "front lines" and therefore most directly affected by staffing decisions. Finally, this study is likely to be of interest to policy makers as the findings may inform discussions regarding mandatory minimum staffing levels and how continued nurse shortages may impact hospital quality.

CHAPTER 2

Literature Review

Nurse Staffing and Patient Outcomes

This chapter discusses the impact of nurse staffing and quality outcomes. The chapter begins with an overview of quality outcomes, specifically nurse sensitive indicators (e.g., pressure ulcers, catheter associated urinary tract infections (CAUTI), patient falls) and adverse patient outcomes/events (e.g., failure to rescue, inpatient mortality, medication errors). Next, the chapter provides an overview of various types of nurse staffing metrics, followed by a review of research related to the association between nurse staffing and adverse outcomes/events, including patient falls. Because patient falls are complex with many causes, the chapter also reviews other factors that may influence patient falls. The chapter concludes with a discussion of the theoretical framework utilized to examine patient falls and the hypothesis that was tested in the study.

Quality Outcomes

Nursing Sensitive Indicators

Significant changes in hospitals brought about by cost containment efforts and competition gave rise to mounting concerns about the impact of staff reductions on quality. As a result, Congress requested the Institute of Medicine to study to what extent nurse staffing levels in hospitals impact quality of care as well as work related injuries (Wunderlich, Sloan, & Davis, 1996). Similarly, in response to restructuring initiatives in hospitals that aimed to reduce hospital costs, the American Nurses Association (ANA) formulated a multi-phase initiative to examine the effects of such efforts on patient outcomes (American Nurses Association, 1999). Since nursing is the largest segment of the hospital workforce, labor savings are often targeted in this area. Concerns about the quality and safety of care gave rise to the examination of staffing and patient outcomes.

From this work came the identification of nursing sensitive indicators (NSI), which are defined as outcomes most affected by nursing care (Appendix A). Each indicator has undergone a development process that includes a comprehensive review of literature and engagement of researchers to evaluate the validity and reliability of supporting studies. A panel of experts was consulted to evaluate face validity and to determine the feasibility of data collection (Montalvo, 2007).

To advance this work, the ANA developed the National Database of Nursing Quality Indicators (NDNQI) to support ongoing monitoring of nurses' impact on quality and safety across the country. These indicators were developed based on Donabedian's quality framework (Dunton et al., 2004) and have been frequently acknowledged in the literature. Currently, 1,900 hospitals worldwide submit data to NDNQI, which is now a part of the Press Ganey Corporation, well known for its expertise in performance measurement and data analytics in the area of patient experience (http://www.nursingquality.org/Content/Documents/NDNQI-International-Flyer.pdf).

Adverse Patient Outcomes/Events

Adverse events are defined as "harm to a patient as a result of medical care or in a health care setting" (Levinson, 2010). While the result of an adverse event is an undesirable patient outcome, it is not always the result of a medical error or poor quality care. Further, adverse events are not always preventable. Adverse events have not been identified by the ANA as nursing sensitive indicators; however, they are empirically related to nurse staffing. Failure to rescue, defined as death following a complication after a surgical procedure (Silber, Williams, Krakauer, & Schwartz, 1992), inpatient mortality, and medication administration errors are three such outcomes. Medication errors are defined as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer" (NCCMERP, 2015, para. 1).

Nurse Staffing Metrics

There are several ways to measure nurse staffing levels in hospitals, and studies have utilized a variety of measures, which has contributed to the difficulty in understanding its impact on the quality of care. Hours per patient day (HPPD) are classified in two ways, direct and indirect care hours, and productive and nonproductive care hours. Direct care hours are those worked by nursing staff that involve providing nursing care to patients and families, whereas indirect care hours are hours provided by supervisory staff, care coordinators, or educators. Productive hours are work hours spent in the direct provision of nursing care whereas nonproductive hours are paid hours not directly involved in care such as education, meetings, or vacations.

Variations of HPPD include total hours per patient day (THPPD), registered nurse hours per patient day (RN HPPD), licensed practical nurse hours per patient day (LPN HPPD), or nurse technician per HPPD (NT HPPD). The denominator, patient days, can also be defined differently, which results in further discrepancies. For example, patient days may include only inpatients in the hospital at midnight. A more reliable methodology adjusts for those patients in observation status and those short-stay surgical patients (Park, Blegen, Spetz, Chapman, & De Groot, 2014)

Skill mix represents the proportional hours of care provided by registered nurses in the total hours of care (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). Skill mix can be measured by the percentage of HPPD for each level of caregiver as described above (i.e., RN HPPD, LPN HPPD). It can also be measured as the percentage of each level of caregiver divided by the total number of caregivers or divided by the total amount of full time equivalents (FTEs). For example, a unit may have 65 staff members and 35 of these staff members are RNs. This would represent a 54% RN skill mix. Conversely, the same unit, with the same members could have 50 FTEs, due to the number of part-time employees, with 30 FTEs of RN staff. This would represent a 60% skill mix. At the shift level, however, skill mix is simply the percentage of RN hours of care per shift. The skill mix may also be defined as RN only or RN and LPN. While the LPN role has been steadily vanishing from hospital settings over the past 15 years, they still exist in some hospitals. Since their role is significantly different from the RN, adding LPN hours to RN hours to determine skill mix could confound the findings.

Registered nurse-to-patient ratio reflects the actual number of patients for whom a RN is responsible for providing care over the course of a shift at the hospital level. If this is the only metric utilized for examining staffing or if this metric is the only one that demonstrates significance in a study, results should be cautiously viewed. The use of NTs is an important consideration in caring for patients. Failing to consider these caregivers presents an incomplete picture. Previous researchers have utilized a RN-to-patient ratio and aggregated it over time. Others have converted it to an organizational metric which can mask significant shift-to-shift or even day-to-day variations. Such is the case with data obtained from the American Hospital Association. Included in this RN-to-patient ratio are all RNs, including those in the inpatient and outpatient settings

More recently, Needleman et al. (2011) utilized a metric derived by taking the target hours of nursing care and comparing them to the actual number of nursing care hours. Target hours of care per shift per unit were derived from a commercially available patient classification system. A difference of eight hours or more below target hours was considered understaffed, and was utilized as the threshold to evaluate the association between nurse staffing and the dependent variable, mortality. The number of shifts that patients were exposed to understaffing (relative to target) was examined in relation to mortality.

This approach is unique and provides greater insight into the appropriateness of staffing levels based on individual patient need. Other metrics such as HPPD and skill mix represent actual staffing but do not consider whether staffing levels are appropriate. Constructing a measure of staffing variance at the shift level provides the most robust means by which to evaluate the association between nurse staffing and patient outcomes.

Adverse Patient Outcomes/Events

Failure to Rescue

Failure to rescue (FTR), defined as death following a complication after a surgical procedure, is a measure of quality of care in hospitals (Silber et al., 1992). Analysts of FTR assume that complications are not measures of organizational quality of care, but rather more reflective of patient severity of illness and diagnostic coding. When complications occur, the organization's ability to recover or "rescue" the patient is the more relevant measure of quality (Silber et al., 2007).

FTR has gained popularity over the past several years and was identified by the Agency for Healthcare Research and Quality (AHRQ) as a patient safety indicator (PSI) (Farquhar, 2008). It was deemed to be sensitive to nursing care by the National Quality Forum (Blegen, Goode, Spetz, Vaughn, & Park, 2011). However, the definition of FTR varies based on the number of complications that are included in the rates. For example, Silber's original definition included 15 categories of complications with some categories containing up to five different complications. This stands in contrast to Needleman and colleagues (2002) who utilized only six complications deemed to be those most sensitive to nursing care and AHRQ that utilizes seven complications.

Five previous studies have examined the relationship between nurse staffing and FTR. The results of these studies have been mixed (Aiken, Clarke, Sloane, et al., 2002; Blegen et al., 2011; Halm et al., 2005; Needleman et al., 2002; Talsma, Jones, Guo, Wilson, & Campbell, 2013). Two of these studies are particularly notable. The landmark study in 2002 by Aiken and colleagues has been cited over 3,500 times and is widely utilized as evidence to suggest a negative relationship between nurse staffing and patient outcomes. The authors found that after adjusting for patient and hospital characteristics, every additional patient per nurse was associated with a 7% increase in the odds of FTR. However, the authors of another study found no observable association between nurse staffing and FTR (Talsma et al., 2013).

An important distinction of the Talsma et al. study was that data were obtained at the unit level versus the hospital level and included actual staffing levels versus self-reported staffing levels. An additional strength of this study was that the months of patients' deaths were matched to staffing levels on the unit. While this study takes advantage of some unique data to provide insight into why there may be conflicting relationships, it has not garnered the same level of attention, possibly because the findings do not support the association between nurse staffing and FTR.

Mortality

Similar to FTR, mortality has been identified as a PSI by the AHRQ. Many studies have found a statistically significant association between a number of nurse staffing metrics and inpatient mortality (Aiken et al., 2011; Aiken, Clarke, & Sloane, 2002; Aiken et al., 2014; Cho et al., 2003; Diya, Van den Heede, Sermeus, & Lesaffre, 2012; Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Glance et al., 2012; Liang, Chen, Lee, & Huang, 2012; Needleman et al., 2011; Tourangeau et al., 2007; Tourangeau, Giovannetti, Tu, & Wood, 2002). Researchers have noted that nurse staffing is associated with mortality, but the relationship may not be linear. Specifically, increasing staffing may decrease mortality when staff levels are already low, but increasing staffing may have decreased ability to reduce mortality when staffing levels are already high. For example, Mark and colleagues (2004) found that on units where existing levels were at the 25^{th} percentile, adding more staff improved mortality. In contrast, for units with staffing at or above the 75^{th} percentile, adding more staff did not decrease mortality. This finding is consistent with previous studies that evaluated nurse staffing and patient falls suggesting that, at certain staffing levels, increased staffing does little to prevent adverse outcomes (Dunton et al., 2004; Staggs, Knight, & Dunton, 2012).

Using skill mix as a staffing metric, studies by Tourangeau and colleagues consistently demonstrated lower 30-day mortality in hospitals with a higher percentage of registered nurses (Tourangeau et al., 2007; Tourangeau et al., 2002). Blegen et al. (1998) however, found that higher total hours of care were positively associated with mortality, although the results were not statistically significant.

A more recent study utilized shift level data to assess the association between nurse staffing and mortality in a large tertiary hospital (Needleman et al., 2011). At the shift level, the study examined the variance in actual nurse staffing from target nurse staffing levels. A positive association was found between increased exposure to staffing that was below-target by eight hours or more per shift and inpatient mortality. This study is important because it utilized shift level data and eliminated potential aggregation bias.

Medication Administration Errors

Studies examining the association between nurse staffing and medication administration errors (MAE) have also had mixed results. Several studies found that higher RN skill mix was associated with fewer MAE (Blegen et al., 1998; Blegen & Vaughn, 1998; Frith, Anderson, Tseng, & Fong, 2012; Hall et al., 2004; Patrician et al., 2011) and higher total hours of care were associated with fewer MAEs (Blegen et al., 1998; Whitman, Kim, Davidson, Wolf, & Wang, 2002). Similar to other studies that found limited improvements in patient outcomes with additional staff, Blegen and Vaughn (1998) identified a nonlinear relationship between MAE and RN skill mix. MAE decreased as the RN skill mix approached 85%, at which point MAE increased. Conversely, neither RN skill mix nor total hours of care were associated with MAE colleague when staffing was measured at the unit level (Breckenridge-Sproat et al., 2012). The use of LPNs on certain units was found to have a positive association with MAE, indicating that more LPNs were associated with more medication administration errors (Breckenridge-Sproat et al., 2012; Hall et al., 2004; Patrician et al., 2011)

Nursing Sensitive Indicators

Pressure Ulcers

Studies that have examined the association between nurse staffing and hospital or unit acquired pressure ulcers have demonstrated mixed results. Two studies found no significant relationship between RN HPPDs and the development of pressure ulcers (Mark, Harless, McCue, & Xu, 2004; Needleman et al., 2002). However, another study established that more licensed nurses in a hospital was significantly associated with a lower rate of pressure ulcers (Unruh, 2003). Blegen and colleagues (1998) detected a curvilinear relationship between RN skill mix and pressure ulcers. As the percentage of RN hours increased, pressure ulcers decreased, however, when RN hours reached 87.5% of the total hours per patient day and beyond, pressure ulcers increased (Blegen et al., 1998). This curvilinear relationship was not seen in a later study by Blegen and colleagues, however, it did reveal a trend toward lower pressure ulcers with higher total hours of care in the intensive care units (Blegen et al., 2011). Yet other studies found that lower THPPDs were associated with lower rates of pressure ulcers (Cho et al., 2003; Dunton, Gajewski, Klaus, & Pierson, 2007).

Choi and Staggs (2014) examined six self-reported, nurse staff variables to determine a correlation with pressure ulcers. Both RN skill mix and RN-perceived staffing adequacy were significant predictors of fewer pressure ulcers. The conclusion from two comprehensive reviews of the literature was that the relationship between nurse staffing and pressure ulcers lacked empirical support (Lake & Cheung, 2006; Lang et al., 2004).

Catheter Associated Urinary Tract Infections

Researchers who have examined nurse staffing and catheter associated urinary tract infections (CAUTIs) in various populations of patients reported consistent findings (Esparza, Zoller, White, & Highfield, 2012; Kovner & Gergen, 1998; Needleman et al., 2002). In each patient population that was studied, a negative association was found between nursing staffing, as measured by THPPD, RN skill mix and RN/adjusted patient day, and the development of urinary tract infections.

Patient Falls

Staffing. Several studies have examined the relationship between nurse staffing and patient falls in hospitals. Consistent with studies using different outcomes, these studies included alternative measurements of nurse staffing, such as total hours of nursing care per day (THPPD), total RN hours of nursing care per day (RN HPPD), nurse-to-patient ratio, and skill mix. Additional studies also measured characteristics of nurse staff such as education, specialty certification, and experience. Consequently, the findings of these studies were conflicting, sometimes even within the same study.

In evaluating the total hours of nursing care and patient falls, three studies showed no association (Blegen et al., 1998; Blegen & Vaughn, 1998; Breckenridge-Sproat et al., 2012; Cho et al., 2003). Other studies, however, showed that higher nurse staffing levels were significantly associated with fewer falls on step-down, medical-surgical, and medical units but not surgical units (Dunton et al., 2004). Consistent with other outcomes, this relationship was nonlinear on medical units, medical-surgical units, and surgical units.

A nonlinear relationship between nurse staffing levels and patient falls was also observed in a study by Staggs and colleagues (2012) where units with lower staffing levels had lower falls rates up to the median THPPD of 9.1. As THPPD increased to beyond 12.5, falls began to decrease. The researchers suggested that this finding could be attributed to a “diffusion of responsibility” where staff tended to focus more narrowly on their own specific assignments when staffing levels were high, whereas staff assumed more ownership and responsibility for the entire patient population when staffing levels were low.

When examining only the RNHPPDs, three studies demonstrated a decrease in patient falls with increasing RN hours (Blegen & Vaughn, 1998; Dunton et al., 2004; Sovie & Jawad, 2001). However, there are conflicting results when examining the effect of licensed practical nurses (LPNs) on patient falls. An increased number of licensed practical nurses (LPNs) was associated with fewer falls (Bae, Kelly, Brewer, & Spencer, 2014). In another study, researchers concluded that an additional hour of LPN care actually increased the fall rate by 2.9% in non-ICU settings (Lake, Shang, Klaus, & Dunton, 2010). Notably, 45% of the units in the study did not utilize any LPNs, thus, the findings should be interpreted with caution.

With RN skill mix as the independent variable, three studies determined that higher RN skill mix was associated with fewer falls on certain units (Dunton et al., 2007; Patrician et al., 2011; Staggs et al., 2012); two studies found no association (Breckenridge-Sproat et al., 2012; Hall et al., 2004); and two studies found a positive association (Grillo-Peck & Risner, 1994; Langemo et al., 2002; Unruh, 2003). Grillo-Peck and Rinser (1994) examined the impact of restructuring inpatient nursing units on patient falls. In an effort to contain costs, RN staffing was decreased and the use of nurse technicians (NT) was increased. Consequently, the overall RN skill mix dropped from 80% pre-restructuring to 60% post-restructuring and was associated with fewer patient falls. This finding is consistent with Unruh who noted that for every 10% increase in licensed nurse/total staff, patient falls increased by 3% (Unruh, 2003).

Patrician's study is particularly insightful as it presents shift-level data as opposed to hospital or unit level data. Results demonstrated that each 10% decrease in RN skill mix was associated with a 36% increase in the likelihood of a fall on critical care units and a 30% increase on medical surgical units. This association, however, was not evident for step-down units. It is important to note that this study utilized the Military Nursing Outcomes Database (MilNOD), which included data from 13 hospitals and 56 units at the shift level. Similarly, Brenkenridge-Sproat and colleagues (2012) utilized the same shift level data from the MilNOD. These authors, however, selected a subset of four hospitals and 23 units and aggregated shift level data to unit level data. Results differed between the studies suggesting that more granular data (i.e., shift level data) illuminates rather than masks staffing variation.

In 1999, California was the first state to mandate hospitals to maintain minimum licensed nurse-to-patient ratios. A number of studies have sought to determine the impact of this staffing requirement on both patient and nurse outcomes. Findings from Donaldson et al. (2005) revealed a 20.8% increase in the mean total RN HPPD and a 7.4% increase in the mean THPPD on medical surgical units since the implementation of the legislation. Staffing ratios, defined as the number of patients cared for at any one time by nurses, decreased by 17.5% for RNs and 16% for licensed staff (i.e., RNs, LPNs). In essence, staff workload was lightened. There were no significant staffing changes on step-down units because staffing levels in these areas were already at a level consistent with the mandated ratios before the legislation was passed. Despite these staffing improvements, there were no significant improvements in patient falls or pressure ulcers on medical-surgical units or step-down units. Intensive care units were not evaluated in this study.

In two separate reviews of the literature, researchers considered the strength of evidence related to patient falls. The first set of researchers examined 43 studies and concluded that there was insufficient evidence to suggest a relationship between nurse staffing and patient falls (Lang et al., 2004). Two years later, Lake and Cheung examined 11 studies and concluded that the evidence was inconclusive due to variation in research designs and the multifactorial nature of the reasons for falls (Lake & Cheung, 2006). One specific explanation for the mixed and inconclusive findings was the variation in how nurse staffing was operationalized and which unit of measurement was used (e.g., hospital versus unit versus shift). Lake and Cheung recommended further investigation into the topic.

An overview of the studies that examined the relationship between nurse staffing levels and patient falls, along with the measures used, can be seen in Table 1.

Table 1
Studies Examining the Relationship between Nurse Staffing Levels and Falls in Hospitalized Patients

Source	Measurement	Unit of Measurement
Bae, S-H., Kelly, M., Brewer, C.S., & Spencer, A. (2014). Analysis of nurse staffing and patient outcomes using comprehensive nurse staffing characteristics in acute care nursing units. *Journal of Nursing Care Quality*, *29*(1), 1-9.	HPPDs* for RNs, LPNs and NT Skill mix - percentage of total nursing hours worked by each caregiver level	Nursing unit
Blegen, M. A., Goode, C. J., & Reed, L. (1998). Nurse staffing and patient outcomes. *Nursing Research*, *47*(1), 43-50.	Nursing turnover – not defined All hours per patient day RN HPPD	Nursing unit
Blegen, M. A., & Vaughn, T. (1998). A multisite study of nurse staffing and patient occurrences. *Nursing Economic$, 16*(4), 196.	THPPD* – THPPD included RNs, LPNs and NT/total patient days on unit per month RN skill mix – proportion of RN hours/total of all hours	Nursing unit
Breckenridge-Sproat, S., Johantgen, M., & Patrician, P. (2012). Influence of unit-level staffing on medication errors and falls in military hospitals. *Western Journal of Nursing Research*, *34*(4), 455-474.	THPPD* - included RNs, LPNs, and NT RN HPPD – RN care hours/total care hours per patient day	Shift level data aggregated to the nursing unit level
Cho, S.-H., Ketefian, S., Barkauskas, V. H., & Smith, D. G. (2003). The effects of nurse staffing on adverse events, morbidity, mortality, and medical costs. *Nursing Research, 52*(2), 71-79.	All hours – total productive hours worked by all nursing personnel/day* RN hours – total productive hours by RN/day RN portion (skill mix) – RN hours/all hours	Patient group level (DRG)
Donaldson, N., Bolton, L. B., Aydin, C., Brown, D., Elashoff, J. D., & Sandhu, M. (2005). Impact of California's licensed nurse-patient ratios on unit-level nurse staffing and patient outcomes. *Policy, Politics, & Nursing Practice*, *6*(3), 198-210.	Nursing care hours – productive hours worked by RNs, LVNs and non-RN, non-LVN hours. RN nursing care hours – total number of productive hours worked by all direct care RNs including contract staff. LVN nursing care hours – same as above except for LVNs Non-RN and non-LVN hours – same as above except for non-RN and non-LVN Contracted hours – productive hours worked in direct care by agency or registry nurses Skill mix – percentage of RN nursing care hours from total nursing care hours. Total patient days – midnight census plus number of observation patients/month.	Nursing unit

Source	Measurement	Unit of Measurement
Dunton, N., Gajewski, B., Taunton, R. L., & Moore, J. (2004). Nurse staffing and patient falls on acute care hospital units. *Nursing Outlook, 52*(1), 53-59. doi: 10.1016/j.outlook.2003.11.006	Nursing HPPD – Total number of hours worked by nursing staff members who are involved at least 50% of the time in direct patient care/Total number of patient days. Patient days measured by midnight census. Skill mix - Percent of total nursing hours provided by RNs, LPNs/LVNs, and NT % Contracted staff - Percent of total nursing hours provided by contract (agency) nursing staff of all skill levels.	Nursing unit
Dunton, N., Gajewski, B., Klaus, S., & Pierson, B. (2007). The relationship of nursing workforce characteristics to patient outcomes. *OJIN: The Online Journal of Issues in Nursing, 12*(3).	THPPDs RN HPPDs Skill mix % Total hours of care provided by agency staff. All definitions consistent with those of NDNQI.	Nursing unit
Grillo-Peck, A., & Risner, P. (1994). The effect of a partnership model on quality and length of stay. *Nursing Economic$, 13*(6), 367-372, 374.	Evaluated falls pre- and post-restructuring which changed skill mix from 80% to 60% RNs on one inpatient unit.	Nursing unit
Hall, L. M., Doran, D., & Pink, G. H. (2004). Nurse staffing models, nursing hours, and patient safety outcomes. *Journal of Nursing Administration, 34*(1), 41-45.	Nurse staffing mix – percentage of each level of staff with direct care responsibilities.	Nursing unit
Lake, E. T., Shang, J., Klaus, S., & Dunton, N. E. (2010). Patient falls: association with hospital Magnet status and nursing unit staffing. *Research in Nursing and Health, 33*(5), 413-425.	Nursing HPPD – Total number of hours worked by nursing staff members who are involved at least 50% of the time in direct patient care/Total number of patient days* Agency staff – percentage of hours supplied by contract or agency RNs.	Nursing unit
Langemo, D. K., Anderson, J., & Volden, C. M. (2002). Nursing quality outcome indicators: the North Dakota study. *Journal of Nursing Administration, 32*(2), 98-105.	Staff mix – percent of RN care hours/total care hours THPPD – total productive hours worked by nursing staff with direct care responsibilities*	Nursing unit
Liu, L.-F., Lee, S., Chia, P.-F., Chi, S.-C., & Yin, Y.-C. (2012). Exploring the association between nurse workload and nurse-sensitive patient safety outcome indicators. *Journal of Nursing Research, 20*(4), 300-309.	Scheduled hours (self-reported) Actual hours worked (self-reported) Overtime (self-reported) Patient-nurse ratio (self-reported)	Shift level
Patrician, P. A., Loan, L., McCarthy, M., Fridman, M., Donaldson, N., Bingham, M., & Brosch, L. R. (2011). The association of shift-level nurse staffing with adverse patient events. *Journal of Nursing*	RN skill mix – proportion of hours worked by each skill level. Total hours per patient per shift – all hours worked by nursing staff during	Shift level

Source	Measurement	Unit of Measurement
Administration, 41(2), 64-70.	shift/total number of patients at start of shift.	
Sovie, M. D., & Jawad, A. F. (2001). Hospital restructuring and its impact on outcomes: nursing staff regulations are premature. *Journal of Nursing Administration, 31*(12), 588-600.	FTEs for each skill level HPPD* - hours worked per patient day for all staff. RN HPPD NT HPPD Other HPPD – included LPNs, clerks, and managers	Nursing unit
Staggs, V. S., Knight, J. E., & Dunton, N. (2012). Understanding unassisted falls: Effects of nurse staffing level and nursing staff characteristics. *Journal of Nursing Care Quality, 27*(3), 194-199.	THPPD – sum of all RNs, LPNs, and NT hours/total patient days on unit for the month. Skill mix - proportion of month's total nursing care hours provided by RNs	Nursing unit
Unruh, L. (2003). Licensed nurse staffing and adverse events in hospitals. *Medical Care, 41*(1), 142-152.	Number of licensed staff Ratio of licensed staff/patient load (defined as actual number of patients cared for, with and without adjusting for patient acuity) Patient load – equals number of inpatients in a year multiplied by their length of stay, plus estimated outpatient "days of care". Proportion of licensed staff/total nursing staff.	Hospital

*Study does not define a patient day
**Study does not address patient turnover or churn

Other contributing factors to patient falls. Several studies have examined other factors related to patient falls and are presented for contextual purposes. For example, a history of previous falls has been identified as a risk factor for future falls (Mackintosh, Hill, Dodd, Goldie, & Culham, 2006; Stalenhoef, Diederiks, Knottnerus, Kester, & Crebolder, 2002). Other patient-related factors such as age, gender, confusion and delirium, mobility, medications, and toileting along with extrinsic or environmental factors are reviewed.

Age. Falls among hospitalized patients tend to occur more frequently for those over 65 years of age (Center for Disease Control and Prevention, 2005b; Morse, Tylko, &

Dixon, 1987). Consequently, many of the studies that explored factors associated with falls limited the study population to adults over some defined older age (Grundstrom, Guse, & Layde, 2012; Janken, Reynolds, & Swiech, 1986; Stevens & Sogolow, 2005). In one study, researchers examined a younger population in a neuroscience unit and discovered that 32.5% of falls occurred among the 40-49 year age group (Brown & Kiss, 1979). The incidence of falls for hospitalized patients over 65 years of age ranged from 37% to 83% (Swartzbeck, 1983; Walshe & Rosen, 1979).

Gender. Studies examining gender as a risk factor for falls occurring in the hospital setting demonstrated inconsistent results. Four studies found that women fall more often than men (Ackerman et al., 2010; Krauss et al., 2007; Stolze et al., 2004; Walshe & Rosen, 1979), however only the Ackerman and colleagues' study reached statistical significance. Alternative studies suggested that men fall more often than women (Capone, Albert, Bena, & Morrison, 2010; Halfon, Eggli, Van Melle, & Vagnair, 2001; Hendrich, Bender, & Nyhuis, 2003). Further, the risk for falling multiple times in a hospital was greater for men than women (Hitcho et al., 2004). Comparing the risk of falling by gender among community-dwelling older adults was significant only for those over the age of 85 years, whereby men were 41% more likely to fall than women.

There were also documented gender differences with respect to the consequence of falls. Three studies reported that being female was associated with a decreased risk of injury following a fall (Capone, Albert, Bena, & Tang, 2013; Hitcho et al., 2004; Krauss et al., 2007). Similarly, among 22,560 cases of older adults admitted to the emergency department for non-fatal fall related injuries, 70.5% were women, yet the hospitalization rate for injuries sustained from the fall was 1.8 times higher for women than for men (Stevens & Sogolow, 2005).

In contrast, an investigation into all fatal falls that occurred among adults 60 years and older in a Midwest county in 2005 revealed a female to male ratio of 1.86:1 (Deprey, 2009). This finding contradicts a finding by the Centers for Disease Control and Prevention that suggested men were more likely to die following a fall than women (Center for Disease Control and Prevention, 2005b).

Confusion and delirium. Studies have demonstrated that confusion and/or delirium are significant risk factors for hospitalized patients falling (Bates et al., 1995; Hendrich et al., 2003; Hitcho et al., 2004; Janken et al., 1986; Oliver et al., 2004). However, these conditions were not found to be significant risk factors for fall-related injuries (Capone et al., 2013; Hitcho et al., 2004; Janken et al., 1986; Krauss et al., 2007). These findings contradict the findings of a study performed in a long-term care facility in which researchers demonstrated that dementia was positively associated with fall-related injuries (Myers, Baker, Van Natta, Abbey, & Robinson, 1991). Further exploration into the etiology of falls among patients with dementia in a nursing home revealed that patients who fell had greater variability in stride length versus those who did not fall (Nakamura, Meguro, & Sasaki, 1996). In community-dwelling, older adults with Parkinson’s disease and other Parkinsonian syndromes, dementia was correlated with a risk of falling but was not correlated with a risk of fall-related injuries such as fractures (Wielinski, Erickson-Davis, Wichmann, Walde-Douglas, & Parashos, 2005; Wood, Bilclough, Bowron, & Walker, 2002).

Impaired mobility. Skelton noted that after the age of 30, strength and endurance declines up to 10% per decade (as cited in World Health Organization Europe, 2004, p. 8). The loss of muscle strength is a major cause of falls among the elderly and is further compounded by hospitalization (Creditor, 1993). Even younger people lose muscle strength when they are inactive. Muller determined that young men on bed rest lost strength at a rate of up to 1.0% to 1.5% per day or 10% per week. Without any voluntary muscle activity, loss of strength was as much as 5% per day (as cited in Creditor, 1993, p. 2).

When physical endurance and strength diminishes, the capacity to perform activities of daily living is marginalized and the ability to recover from a stumble or slip declines. Two studies performed in inpatient settings examined mobility issues and/or weakness; the results were conflicting. Using multivariate analysis, Hitcho and colleagues established that 81% of patients who fell were weak. The results, however, were not statistically significant (Hitcho et al., 2004).

Janken et al. (1986) identified that generalized weakness and decreased mobility of the lower extremities was associated with an increased risk of falling since surgical procedures on the lower extremities may make a patient less mobile. Patients who undergo orthopedic procedures are most often classified as high risk for falls. To determine who was at greatest risk, Ackerman evaluated only post-operative orthopedic patients and found those patients who underwent total knee arthroscopy (TKA) or a revision of a TKA, had significantly increased odds of falling as compared to patients who underwent other orthopedic procedures.

Some diseases also have the potential to cause balance problems and are therefore associated with an increased risk of falls. Patients with neurological diseases, in particular Parkinson's disease (PD), have fall rates as high as 70% when assessed over a one-year time period (Wood et al., 2002). In an age-matched controlled study, 50.8% of individuals with PD had fallen compared to 14.5% of healthy subjects (Bloem, Grimbergen, Cramer, Willemsen, & Zwinderman, 2001).

A puzzling phenomenon closely associated with falls in people with PD is called freezing of gait (FOG). The clinical presentation of FOG occurs when a person suddenly stops moving or is unable to start walking for no obvious reason. Freezing of gait generally lasts about 10 seconds but can last as long as 30 seconds and then spontaneously resolves. There is an increased risk of falling when people attempt to break through the freeze or block. This phenomenon is not present in all patients with PD, but when it is, the effects can be disabling (Bloem, Hausdorff, Visser, & Giladi, 2004).

Toileting. The Agency for Healthcare Research and Quality developed a toolkit to be used to reduce falls among hospitalized patients (Agency for Healthcare Research and Quality, August, 2013). One of the prevention strategies in the toolkit is a routine hourly rounding protocol for nursing staff that includes assessing patients for toileting needs. This recommendation is based on the evidence that elimination is a risk factor for falls in the hospital (Ackerman et al., 2010; Brown & Kiss, 1979; Hendrich et al., 2003; Hitcho et al., 2004; Janken et al., 1986). Elimination-related falls are often cited as those that occur when ambulating to the bathroom, while in the bathroom, or on a bedside commode.

The rate of incontinence for hospitalized older adults is between 40% and 50%, however, in community-dwelling older adults the rate of incontinence is much lower, at between 5% and 15% (Resnick & Yalla, 1985). Posited explanations for this difference are that hospitalization disrupts normal routines, the height of the bed may seem daunting, and patients are often tethered to equipment such as intravenous fluids or oxygen tubing. This finding does not suggest that all patient falls are due to incontinence but rather speaks to needing assistance with toileting.

Medications. An association between the use of various medications and inpatient falls has been examined with contradictory results. Through a meta-analysis and systematic review of 40 studies, of which eight were conducted in the hospital setting, researchers detected a minor association between falls and the use of psychotropic medications, neuroleptics, sedative/hypnotics, antidepressants, and benzodiazepines (Leipzig, Cumming, & Tinetti, 1999). In another study, researchers compared patients who fell and sustained serious injuries in the hospital to those who did not fall. Findings showed a greater use of sedatives/hypnotics, laxatives, and stool softeners among those who fell, although the use of medications was not a statistically significant risk factor for patient falls (Bates et al., 1995). When the researchers controlled for confusion and comorbidities, none of the drug classifications were independently associated with falls. Mixed results have been demonstrated in studies that examined the relationship between the use of hypnotics and antidepressants and falls in hospitalized patients (Hitcho et al., 2004; Janken et al., 1986).

The use of benzodiazepines as a contributor to falls has been studied because of the sedative and hypnotic-like effects of this drug classification. Benzodiazepines, a central nervous system depressant, are used to treat anxiety and insomnia. As previously noted, problems with sleeping have been shown to contribute to falls (Ray, Griffin, & Downey, 1989). In the community setting, the use of benzodiazepines has been positively associated with falls (Ray et al., 1989; Sorock & Shimkin, 1988). However, other researchers found no associated increase in risk of falls in community-dwellers due to benzodiazepines (Grisso et al., 1991; Rashiq & Logan, 1986). Two studies examined the association between benzodiazepine use and patient falls in an inpatient setting. While the use of benzodiazepines in all hospitalized patients was greater among individuals over the age of 70 who fell versus individuals over the age of 70 who did not fall, it failed to reach statistical significance (Gales & Menard, 1995). However, for patients who fell on a geriatric psychiatry unit, a statistically significant difference was found between the use of benzodiazepines and neuroleptics when used on an as needed basis (Aisen, Deluca, & Lawlor, 1992). Other medications that may cause dizziness or disorientation, such as vasodilators and tranquilizers, have also been shown to be associated with an increased risk of falls (Myers et al., 1991).

Since many falls are attributed to toileting, the use of diuretics as a contributing factor in hospitalized patients seems plausible, yet no relationships between diuretics and falls have been detected (Bates et al., 1995; Hitcho et al., 2004). Nevertheless, among long-term care patients, the use of diuretics was positively associated with fall injury (Myers et al., 1991).

Environmental factors. Environmental factors that may contribute to falls of hospitalized patients include inadequate lighting, trip hazards, poorly functioning equipment, position of bedrails, wet floors, inappropriate footwear, positioning of personal items out of reach, equipment cables or tubing, and the height of beds and chairs (Kulikowski, 1979; Oliver, Healey, & Haines, 2010). For example, researchers examined the height of hospital beds as a factor that would place a patient at risk for falling (Tzeng & Yin, 2007). The authors determined that hospital bed frames tended to be higher than home beds. Since hospital bed frames can be raised and lowered, they could be inadvertently left in a high position thereby compromising patient safety. In this study, patients who were identified as high risk for falls had their beds left in a higher position than patients who were not identified as high risk for falls. This finding was consistent throughout all shifts. Additionally, the average staff working-height measurement of all beds was significantly higher on the weekend versus the weekday. One explanation offered by the researchers was that higher patient-to-nurse ratios on the weekend resulted in less attentiveness to basic safety precautions such as returning the bed to its lowest position.

Theoretical Framework

Donabedian's Quality Outcome Model

Donabedian's structure-process-outcome framework is often used to study factors that promote or hinder quality (Figure 1). In this model, characteristics of structures in which care is provided influence the processes of care, which in turn, facilitate better or worse quality outcomes (Donabedian, 1988).

Structure → Process → Outcome

Figure 1. Donabedian's Quality Outcome Model.

Structure refers to material resources such as money, facilities, and equipment; human resources such as the number of staff and their qualifications; and organizational characteristics such as the type and composition of the staff and reimbursement methodologies (Donabedian, 2005). The structural component of this study was staffing levels by shift (Figure 2).

Process is the care provided to patients to improve health and/or well-being. Process includes adherence to protocols, treatment selection, and communication patterns and is simply identified as “doing the right things” (Mitchell, Ferketich, & Jennings, 1998). As related specifically to falls, processes include the use of bed and chair alarms, hourly rounding, falls prevention protocols, use of gait belts, and appropriate footwear. For the purpose of this study, *processes of care* was not a measured construct.

Outcomes are patient care results, including patient satisfaction, restoration of health, and adverse events such as falls. Outcomes can be directly influenced by specific process variables, while structure indirectly influences outcomes by working through the processes. Several researchers, however, have demonstrated a direct association between nurse staffing (structure) and various patient outcomes (Cho et al., 2003; Dunton et al., 2004; Needleman et al., 2011). Therefore, in this study it was generally hypothesized that below recommended nurse staffing levels (understaffing) were associated with greater likelihood of a patient fall.

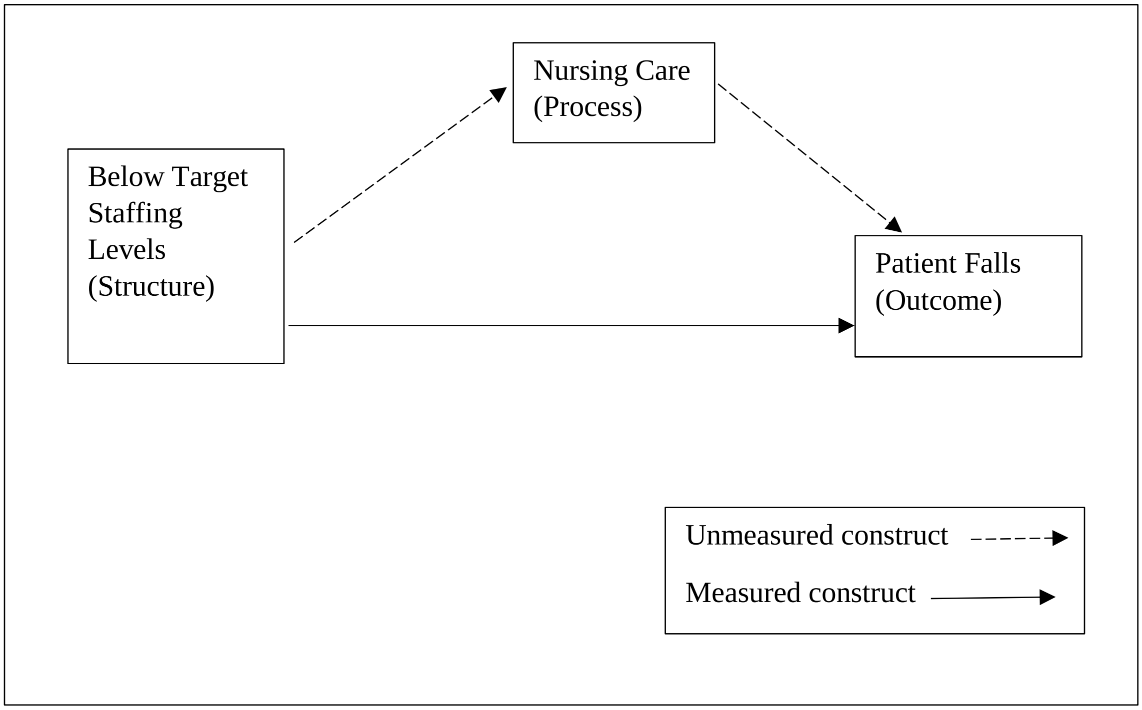

Figure 2. Conceptual model for differences in actual to recommended staffing and patient falls.

Resource-Based Theory of the Firm

One organizational theory that complements Donabedian's model is the resource-based view of the firm that links internal characteristics, defined as resources and capabilities, with a firm's performance (Barney, 1991). According to this theory, a competitive advantage is gained when a firm possesses resources and capabilities that are difficult to replicate. Researchers have used resource-based theory to examine relationships between nurse staffing and changes in patient conditions as well as nurse staffing and financial outcomes in nursing homes (Weech-Maldonado, Meret-Hanke, Neff, & Mor, 2004; Weech-Maldonado, Neff, & Mor, 2003). Since hospitals also exist in highly regulated environments, are motivated to improve quality and safety, and are dependent on third party reimbursement, this study used resource-based theory to posit that nurse staffing variations may be associated with patient falls.

Hospitals compete for human resources in order to carry out their missions and compete for patients based on the types of services provided, amenities, and the quality of care (Morrisey, 2001). Nurses comprise the largest part of the labor force within hospitals; therefore, recruitment and retention of these professionals is important to the performance of the organization. Organizational capabilities include knowledge which can be classified as articulable or tacit (Weech-Maldonado et al., 2004). Articulable knowledge is that which can be codified and easily transferred, such as knowledge obtained through education (Busch & Richards, 2000). In contrast, tacit knowledge is not easily codified or transferred yet it is used by all people, typically unknowingly. Dahlboom and Mathiassen (as cited in Busch, 2000) describe tacit knowledge as follows:

> We have no idea how we do a lot of the things that we know how to do. Among those are the very fast feats of perception, recognition, attention, information retrieval, and motor control. We know how to see and smell, how to recognize a friend's face, how to concentrate on a mark on the wall … These are definitely tacit competencies. If there are rules involved, we have no idea what they might be. (p. 51)

Nurses gain tacit knowledge through exposure to different experiences that contribute to patient outcomes (de Cordova, Phibbs, Schmitt, & Stone, 2014). Therefore, it is incumbent upon hospitals to retain not only the appropriate number of nurses but also those with years of experience.

Resource-based theory may also be applied at the shift level or unit level within an organization. Analogous to organizations competing for resources and capabilities to ensure competitive advantage, nursing units also face resource acquisition and distribution challenges when trying to provide high-quality care. There are a finite number of resources available within a hospital, and nurse leaders are responsible for allocating resources appropriately to maximize their utility. Staffing float pools, the use of temporary agency nurses, and the use of interdepartmental floating are all part of comprehensive staffing plans to adjust for variation in patient census or staffing vacancies. In spite of these plans, however, there are times when there are not enough available nurses and units are left understaffed.

Hospital units, and shifts within these units, consist of bundles of unique resources with tacit knowledge and routines that are required to provide high quality care. Staffing differences that represent departures from these preferred bundles (i.e., circumstances in which recommended staffing levels match actual staffing levels) may interfere with organizational routines that are optimized to take advantage of these resource bundles. Negative differences in recommended-to-actual staffing (i.e., overstaffing) may create additional coordination challenges among care team members and, as noted earlier, result in a diffusion of responsibility whereby important monitoring and care giving activities are missed because it is assumed they are being taken care of by other care team members. In contrast, positive differences in recommended-to-actual staffing (i.e., understaffing) is associated with greater nurse workload, which results in nurses having less time to communicate with other caregivers and patients and exchange tacit information needed to coordinate care. In sum, deviations from recommended staffing levels can undermine the value of the resource bundles that provide a *competitive advantage* which, in this case, is the ability to provide high quality care.

Although deviations from recommended staffing levels have the potential to disrupt resource bundles and organizational routines established by these bundles, positive deviations (i.e., understaffing) may be particularly detrimental for patient outcomes. This is true for several reasons. First, understaffing can lead to burnout and turnover, with research demonstrating that nurse turnover and units with high rates of turnover associated with more patient falls as compared to units with lower rates of turnover (S. H. Bae, Mark, & Fried, 2010). Likewise, in nursing homes, infection rates and hospitalization are significantly associated with nurse turnover such that for each RN (per FTE/100 beds) who left, the relative risk of infection increased 30% and the relative risk for hospitalization was 80% (Zimmerman, Gruber-Baldini, Hebel, Sloane, & Magaziner, 2002). At the organizational level, turnover may decrease productivity as new staff members are hired and oriented, often at a significant cost.

Second, as noted above, understaffing is especially more likely to disrupt organizational routines in ways that inhibit coordination between care team members. For instance, on a shift to shift basis, volume and acuity fluctuations can lead to tremendous swings in staffing requirements. With low census or acuity on a unit, a nurse may be reassigned to another unit, which frequently causes staff dissatisfaction. If a nurse is not needed elsewhere he or she could be sent home in order to align with targeted staffing levels. Several organizational pay practices require some minimum pay for staff members in these situations. When census or acuity increases, additional resources may be needed to accommodate patient care needs. It can be difficult, however, to make such accommodations in a timely manner to match staffing needs. For example, hospitals may use overtime to match nurse staffing needs with actual staff resources. Regular use of overtime hours to meet staffing requirements has been perceived by nurses as being associated with adverse patient outcomes due to fatigue and increased work intensity

(Liu, Lee, Chia, Chi, & Yin, 2012; Rogers, Hwang, Scott, Aiken, & Dinges, 2004). Compounding this issue are unplanned staff absences due to illness, family emergencies, exhaustion, and other obligations. The majority of stakeholders and all staff nurses interviewed suggested that the majority of absenteeism was not related to illness and that improving nurse staffing levels would serve as a strategy to reduce absenteeism (Shamian, O'Brien-Pallas, Thomson, Alksnis, & Steven Kerr, 2003).

When staffing needs are misaligned with available staffing resources, patient care frequently suffers in ways that increase the likelihood of patient falls. Specifically, a nurse’s ability to assess, monitor, and respond to required patient needs is threatened. As a result, changes in a patient’s condition may go unnoticed, care needs such as turning and positioning may be missed, response to patient requests may be prolonged, and delays in treatment may occur. In the care of patient falls, response time to toileting needs may increase. More generally, the bundles of resources that make a unit effective may be disrupted. That is to say, organized norms and routines that typically exist when units are fully staffed may be circumvented when short staffed, resulting in ineffective coordination among shift members. Thus, resources that were strengths under fully staffed conditions may become liabilities if understaffing becomes too acute and too severe. Therefore, it was hypothesized that:

H1: Differences in recommended-to-actual staffing will be associated with greater likelihood of a patient fall on a shift

H2: Actual total staffing hours below recommended total staffing hours (understaffing) will be associated with greater likelihood of a patient fall on the shift.

H3: Actual RN staffing hours below recommended staffing hours (understaffing) will be associated with a greater likelihood of a patient fall on a shift.

H4: Actual NT staffing hours below recommended nurse technician (NT) staffing levels (understaffing) will be associated with a greater likelihood of a patient fall on a shift.

CHAPTER 3

Methodology

Study Design and Data Sources

Population and Data Sources

Data for this study were drawn from the time period of January 1, 2013, through December 31, 2013. These data were obtained from two of three fully integrated hospitals within the same hospital system in the Midwest. A children's hospital that is a part of the system was excluded from this study for a number of reasons. Pediatric patients, on average, fall less frequently in hospitals than adult patients (range .83 to 1.33 for pediatrics and 3.44 for adults) (Kingston, Bryant, & Speer, 2010; Staggs, Mion, & Shorr, 2014). There has also been a lack of consensus on the definition and classification of pediatric falls and limited opportunities for benchmarking (Child Health Corporation of America Nursing Falls Study Task Force, 2009; Graf, 2011).

The two hospitals are licensed for a total of 913 beds, are located four miles apart, function under one tax identification number, are governed by the same Board of Trustees, and share the same executive staff. These organizations were designated as Magnet® facilities in 2009 and re-designated in 2013.

Twenty-five adult inpatient units across both hospitals were included in the study. Units were classified as medical (2 units), surgical (2 units), medical-surgical (11 units), moderate acuity (1 unit), step-down (4 units), and critical care (5 units). Obstetrical units and one rehabilitation unit were excluded from the analysis due to data availability issues.

Pediatric units were also excluded for reasons noted earlier. Finally, emergency departments were excluded from the study due to unique differences related to patient flow, geography, and staffing (i.e., 24 hour/day security officers, physicians, advanced practice providers).

Data were drawn from four data sources. Recommended staffing levels (targets) were obtained from the QuadraMed AcuityPlus® Inpatient 2.0, version 8.3.1 nurse resource management system. Recommended nurse staffing hours included hours associated with patient turnover. Actual hours of nursing care were obtained from the hospital payroll system. Patient falls data were extracted from the organization's patient fall database. Finally, the organization's data warehouse was utilized to identify patient age; gender; and census by shift, by day, and by unit.

QuadraMed AcuityPlus. QuadraMed AcuityPlus® is a national vendor software system which is used to help guide decisions regarding the allocation of nursing staff to meet patient care needs. This patient classification system software resides on each clinical workstation and is accessible only by registered nurses. Individual patient data that are included in the system include the patient's medical record number and corresponding patient classification indicators (Appendix B). An acuity score is calculated for each patient by the system and presented as a patient type which corresponds to the number of recommended nursing care hours. An overall patient acuity score is generated along with the recommended nursing care hours per shift for each unit.

Hospital payroll system. Actual hours of nursing care were obtained from the hospital payroll system. The system tracks employee identification number, job classification, rate of pay, productive care hours worked by time of day and by unit(s), non-productive paid hours, paid time off hours, and total paid hours. An inpatient nursing unit is defined in the hospital payroll system as the cost center. These data are routinely collected by the director of nursing operations and utilized for productivity reporting.

To determine the difference in recommended-to-actual staffing (DRAS), actual hours worked per shift per unit were extracted from the hospital payroll system and merged with the recommended nurse staffing hours recorded in the QuadraMed AcuityPlus® system. Data were merged by the unit's cost center number and shift.

Falls database. Patient fall data are routinely collected in the hospital incident reporting system called Improvement and Safety Identification System. Staff members complete an online form that includes the patient name, medical record number, age, gender, patient care unit, patient room number, physician, date and time of day the incident occurred, type of fall, a description of the incident, and any interventions provided. A quality improvement nurse specialist (QINS) routinely queries the hospital incident reporting system for patient falls and transfers the information to a falls database. Additional information for the falls database is then obtained by the QINS from the patient's electronic medical record including: risk assessment prior to the fall, risk assessment score, time since last risk assessment prior to the fall, falls protocol implementation, and use of physical restraints prior to fall.

Data warehouse. The organizational data warehouse is a repository for retrospective detailed clinical patient information including demographics, clinical diagnoses, and treatments. These data come from various interfaces including the electronic medical record. Data were extracted from the warehouse, including patient census by shift, by unit, and by day; gender; and age.

Final Analytic Data Set

A patient-level data set was first constructed by merging data from the falls database and data warehouse using patient medical record numbers. Next, patient-level data were merged with the staffing data at the unit-shift level such that each shift in which a patient was in the hospital became a distinct observation. Since the study examined patient falls as a function of differences in recommended to actual staffing at the shift level, the final analytic data set was longitudinal with repeated observations for patients whose inpatient stay spanned multiple shifts. For example, if Patient A was admitted to the hospital on the evening of January 1 and discharged the morning of January 3, he or she would have six observations: (1) January 1 evening shift; (2) January 1 night; (3) January 2 morning shift; (4) January 2 afternoon shift; (5) January 2 night shift; and (6) January 3 morning shift.

Human Subject Protection

Approval to perform this study was obtained through the Institutional Review Board at the University of Alabama at Birmingham and the Institutional Review Board of the study organization.

Measures and Variables

Dependent Variable

Patient falls. A patient fall was defined as an unplanned descent to the floor (Dunton et al., 2004). This variable was coded dichotomously (1 = patient experienced a fall on a shift; 0 = patient did not experience a fall on a shift).

Independent Variables

Difference in recommended-to-actual staffing. The independent variable of primary interest, difference in recommended-to-actual staffing (DRAS), was calculated by subtracting the actual hours of nursing care per shift from the recommended hours of nursing care per shift, both of which are described in more detail below

Recommended staffing. Recommended staffing requirements are based on specific patient care needs. Each day nurses classify patients based on 24 different indicators that align with patient complexity and specific nursing care requirements (Appendix B). As changes occur throughout the day, patients can be reclassified and new admissions or transfers can be added. For example, if a patient was physiologically stable in the morning when the classification was done, the acuity would be reflective of that stability. However, if later in the day the patient became critically ill requiring more frequent interventions, the nursing care requirements would increase. By reclassifying the patient, the acuity would more accurately reflect the patient's condition and nursing requirements.

The classification of patients is performed electronically via the QuadraMed AcuityPlus® software system, which is accessible from every clinical workstation on the inpatient units. Patients are categorized into one of six different categories or *patient types* based on patient acuity, which in turn provides recommendations about the level of nursing care required for that patient type. Type I patients require the least amount of nursing care while Type VI patients require the most amount of nursing care. In general, Type V and Type VI patients are cared for in the intensive care units (Table 2).

Table 2

Patient Type, Acuity Level, and Associated Hours of Nursing Care

Patient Type	Patient Acuity	Nursing Care Hours/Day
Type I	0.8	0-5
Type II	1.0	5-7
Type III	1.4	7-10
Type IV	2.2	10-14
Type V	3.1	14-20
Type IV	4.6	20+

Recommended staffing levels (targets) are determined based on the target hours per workload index, patient acuity, volume, and patient turnover. Calculations for specific components as defined by the QuadraMed AcuityPlus Inpatient 2.0® are presented in Table 3.

Table 3

Calculation Summary of Nurse Workload Concepts

Workload Concepts	Definition/Calculations
Total Workload Index (WI)	Census x Acuity Summing over all shifts: (total LOS on each shift by patient type/specific shift length) x (specific shift distribution percentage) x relative value (acuity) for the category + ((#admissions x 45 minutes) + (# of discharges x 45 minutes) + (# of transfers in or out x 24 minutes)/THPWI)
LOS adjusted census	Total LOS for all classified patients/24 hours
Unit acuity	Workload index/ LOS adjusted census
Target HPWI	Target number of hours of care for a Type II patient which equates to an acuity level of 1.0
Recommended staff	Workload index x target HPWI

One component of workload predictions is patient volume. Often volume is determined by the census at midnight. However, previous researchers have demonstrated that the midnight census fails to adequately represent the total nursing workload on a unit due to the concept of patient turnover or churn. Defined as the number of admissions, discharges, and transfers on the unit each day, patient turnover or churn contributes to greater demand for nursing resources (Hughes, Bobay, Jolly, & Suby, 2013; Needleman et al., 2011). For example, a nursing unit starts the day at 7:00 a.m. with a census of 24 patients. Throughout the course of the day, six patients were discharged, two were transferred to the intensive care unit, six post-operative patients were admitted, and two patients were admitted from the emergency department. The day ends at midnight with a census of 24 patients. In contrast to this scenario, a unit starts the day with 24 patients, has no discharges, transfers, or admissions and ends the day with the same number of patients. The workload in the first scenario is much greater. To address this concern, the study organization assigned a number of minutes of care for each admission, discharge, and transfer on the unit. Using subject matter experts and observation, the total number of minutes of care required was determined to be 45 minutes for each admission, 45 minutes for each discharge, and 24 minutes for each transfer in or out of the unit. These are then calculated into the workload index for the unit for every shift.

The workload index is then multiplied by the target hours per workload index (HPWI) to obtain the recommended number of staffing hours for each shift on every nursing unit. The recommended number of staffing hours is available for total staffing as well as its component parts: (1) Registered nurse recommended hours, and (2) NT recommended hours.

Actual staffing. Actual staffing levels were derived from the hospital payroll system. All regularly worked hours spent providing direct patient care plus overtime were combined to obtain actual total hours of nursing care by skill level by shift. A shift was defined as eight hours. Staff members who worked 12 hour shifts had their actual hours divided into different shifts. For example, staff members who worked from 7:00 a.m. until 7:00 p.m. had eight hours of work attributed to the morning shift and four hours of work attributed to the afternoon shift.

Recommended-to-actual staffing. Based on the recommended and actual staffing levels, three different continuous variables were constructed: (1) Total difference in recommended-to-actual staffing (T-DRAS); (2) RN difference in recommended-to-actual staffing (RN-DRAS); and (3) NT difference in recommended-to-actual staffing (NT-DRAS). The T-DRAS included all direct nursing care hours and was calculated as:

T-DRAS = Total recommended nurse staffing hours – total actual nurse staffing hours.

The RN-DRAS focused on RN staffing and was calculated as:

RN-DRAS = Total recommended RN staffing hours – total actual RN staffing hours.

The NT-DRAS included only NT staffing and was calculated as:

NT-DRAS = Total recommended NT staffing hours – total actual NT staffing hours.

Based on these calculations, positive values represented understaffing and negative values represented overstaffing.

Understaffing and Overstaffing

Based on the recommended and actual staffing levels, nine additional staffing variables were created to reflect understaffing, overstaffing, and balanced staffing. Understaffing was defined as actual staffing hours that were eight hours or more below the recommended staffing hours and included three dummy variables: (1) understaffing-total (1=shift was understaffed; 0=shift was not understaffed); (2) understaffing RN (1=shift was understaffed with respect to RNs; 0=shift was not understaffed with respect to RNs; and (3) understaffing-NT (1=shift was understaffed with respect to NTs; 0=shift was not understaffed with respect to NTs).

Overstaffing was defined as actual staffing hours that were more than eight hours over the recommended hours of care and included three dummy variables: (1) overstaffing-total (1=shift was overstaffed; 0=shift was not overstaffed); (2) overstaffing-RN (1=shift was overstaffed with respect to RNs: 0=shift was not overstaffed with respect to RNs); and (3) overstaffing-NT (1=shift was overstaffed with respect to NTs; 0=shift was not overstaffed with respect to NTs).

Finally, balanced staffing levels were defined as actual staffing hours that were up to eight hours above recommended hours and up to eight hours below recommended hours and included three dummy variables: (1) balanced staffing-total (1=shift had balanced staffing; 0=shift did not have balanced staffing; (2) balanced staffing-RN (1=shift had balanced staffing with respect to RNs; 0=shift did not have balanced staffing with respect to RNs); and (3) balanced staffing-NT (1=shift had balanced staffing with respect to NTs; 0=shift did not have balanced staffing with respect to NTs). Eight hours was selected because it reflected one caregiver for the shift. In all analyses, balanced staffing was considered the referent.

Control Variables

This study controlled for a number of potential factors associated with patient falls which would confound the study findings. Age was operationalized as a continuous variable measured in years. Gender was coded as a dichotomous variable (1 = female, 0 = male). The study also accounted for potential differences in patient acuity and the likelihood of falls across units with a series of dummy variables defined in accordance with the NDNQI database: medical (referent), critical care, medical-surgical, moderate acuity, step-down, and surgical. Appendix C identifies each unit by unit type and specialty. Finally, time of day was accounted for by three dummy variables corresponding to the three types of shifts used by the hospital: (1) morning shift (referent); (2) afternoon shift; and (3) night shift.

Statistical Analysis

Univariate statistics were utilized to summarize the variables and identify potential data anomalies (e.g., missing data and outliers). Unadjusted bivariate relationships between the variables were assessed using Chi-square tests for categorical variables. A one-way analysis of variance was used to examine the staffing levels across a number of other study attributes, including unit type and shift. Post hoc contrasts using Bonferroni corrections for multiple comparisons were used to assess the differences in staffing across the different levels of these attributes. An independent-samples t-test was used to examine staffing differences between hospitals as well as staffing differences and patient falls.

To assess the association between staffing differences and patient falls, a logistic regression model specification was chosen due to the dichotomous nature of patient falls.

This model was also selected, as opposed to repeated observations and clustered errors, because of the relatively rare occurrence of falls. Three separate models were run, corresponding to the three different staffing variables, which provided more accurate insights into the association between staffing, patient falls, and opportunities to reduce falls.

Each model included the same covariates. All analyses accounted for repeated measurements on the same patients over time and clustering of patients within units. Furthermore, a penalized procedure was utilized due to the fact that patient falls were a rare event in the study sample.

Model 1. Model one included the difference in total recommended-to-actual caregiver hours with the following specifications:

$$logit(Y_{ij}) = B_0 + B_1 x_{1ij} + B_2 x_{2ij} + B_3 x_{3ij} + \sum_{k=\#}^{1} B_k \, x_{ik}$$

where *logit(Y)* is the log-odds of a fall for patient *i* in unit *j*. β_0 was a constant, β_1 was the coefficient associated with the total difference in recommended-to-actual staffing levels (X_{1ij}) for patient *i* in unit *j*. β_2 was the coefficient associated with the shifts that were understaffed, relative to balanced shifts, for patient *i* in unit *j*. β_3 was the coefficient associated with shifts that were overstaffed, relative to balanced shifts, for patient *i* in unit *j*. X_{ik} represents control covariates including age, gender, shift/time of day, and type of unit for patient *i* in unit *j*.

Model 2. Model two examined RN difference in recommended-to-actual caregiver hours and was specified as:

$$logit(Y_{ij}) = B_0 + B_1 x_{1ij} + B_2 x_{2ij} + B_3 x_{3ij} + \sum_{k=\#}^{1} B_k x_{ik}$$

where *logit(Y)* is the log-odds of a fall for patient *i* in unit *j*. β_0 was a constant, β_1 was the coefficient associated with RN variance in recommended-to-actual staffing levels (X_{1ij}) for patient *i* in unit *j*. β_2 was the coefficient associated with the shifts that were understaffed of RNs, relative to balanced shifts of RNs, for patient *i* in unit *j*. β_3 was the coefficient associated with shifts that were overstaffed of RNs, relative to balanced shifts of RNs, for patient *i* in unit *j*. X_{ik} represents control covariates including age, gender, shift/time of day, and type of unit for patient *i* in unit *j*.

Model 3. Model three examined the NT difference in recommended-to-actual caregiver hours and is specified as:

$$logit(Y_{ij}) = B_0 + B_1 x_{1ij} + B_2 x_{2ij} + B_3 x_{3ij} + \sum_{k=\#}^{1} B_k x_{ik}$$

where *logit(Y)* was the log-odds of a fall for patient *i* in unit *j*. β_0 was a constant, β_1 was the coefficient associated with NT variance in recommended-to-actual staffing levels (X_{1ij}) for patient *i* in unit *j*. β_2 was the coefficient associated with the shifts that were understaffed of NTs, relative to balanced shifts of NTs, for patient *i* in unit *j*. β_3 was the coefficient associated with shifts that were overstaffed of NTs, relative to balanced shifts of NTs, for patient *i* in unit *j*. X_{ik} represents control covariates including age, gender, shift/time of day, and type of unit for patient *i* in unit *j*.

CHAPTER 4

Results

Descriptive Statistics

Sample

In this study, there were 627,233 patient observations across 1,095 shifts. A total of 394 observations were eliminated from the sample resulting in a total of 626,839 patient observations and 21,582 unique patients. Observations were deleted if any of the following criteria were met: (1) total recommended or actual hours of care were zero, (2) total actual RN hours were zero, or (3) total recommended RN or NT hours were zero. It was possible to have a low patient census as well as two RNs and no NTs. Consequently, observations that had zero actual NT hours were maintained in the data set. The vast majority of these cases occurred on one particular unit that opened and closed irregularly throughout the year based on capacity needs within the hospital.

Descriptive statistics for the sample are presented in Table 4. Hospital A had 167,525 (26.7%) of the total observations, and Hospital B had 459,314 (73.3%) of the total observations. The percentage of observations was distributed relatively evenly across shifts with 32.1% on the first shift, 32.0% on the second shift, and 35.9% on the third shift. The majority of observations occurred on medical surgical units (286,354 observations, 45.7%), followed by step-down (156,640 observations, 25%), and critical care units (79,425 observations, 12.7%). The moderate acuity unit had the fewest observations (22,296 observations, 3.6%). Patient gender was evenly distributed with

49.2% of admitted patients being females and 50.8% males. The average patient age of was 62.45 years (SD = 17.18), with a range of 18 to 109.

Table 4
Descriptive Statistics for Sample Characteristics

Dichotomous variable	n	%
Falls		
No fall	626,454	99.9%
Fall	395	.1%
Gender		
Male	318,210	50.8%
Female	308,614	49.2%
Observations by shift		
1st shift	201,420	32.1%
2nd shift	200,541	32%
3rd shift	224,878	35.9%
Observations by unit type		
Medical	47,759	7.6%
Surgical	34,575	5.5%
Medical surgical	286,334	45.7%
Moderate acuity	22,296	3.6%
Step-down	15,664	25.0%
Critical care	79,425	12.7%
Observations by hospital		
A	167,525	26.7%
B	459,314	73.3%
Staffing level		
Recommended hours > Actual hours	366,675	58.5%
Recommended hours < Actual hours	259,646	41.4%
Continuous variables	Mean	SD
Total nurse care hours		
Recommended	84.01	31.63
Actual	85.59	31.83
Difference	-1.58	10.02
RN hours of care		
Recommended	62.18	24.62
Actual	62.09	24.72
Difference	.09	7.79
Unlicensed staff hours		
Recommended	21.82	8.76
Actual	23.49	9.39
Difference	-1.67	5.36

Over half (58.5%) of all patient-shift observations were staffed above total recommended hours of care, and 41.4% were staffed below recommended hours of care. Consistent with this result, the mean total actual nursing care hours per shift (M = 85.59, SD = 31.82) exceeded the mean total recommended nursing care hours (M = 84.01, SD 31.63). This difference was due primarily to a greater number of actual hours of care provided by NTs (M = 23.49, SD = 9.39) versus recommended hours (M = 21.82, SD = 8.76). In contrast, the mean actual hours of care provided by RNs (M = 62.09, SD = 24.72) was slightly lower than recommended hours of care for RNs (M = 62.18, SD = 24.62) and represents understaffing.

With respect to the classifications of overstaffing, understaffing, and balanced staffing, 61.9% of all patient-shift observations had balanced staffing levels, 14.4% were understaffed, and 23.8% were overstaffed (Table 5). There were 395 falls during the study period. The fall rate was 1.9 falls/1,000 patient days.

Table 5
Percentage of Observations Under/Over/Balanced Staffing by Level of Caregiver

	Percentage of Observations for Total Caregivers	Percentage of Observations for RN	Percentage of Observations for NT
Understaffing	14.4	12.3	3.3
Overstaffing	23.7	11.9	11.3
Balanced	61.9	75.8	85.4

Bivariate Analysis

Staffing Differences

Staffing differences by hospital. An independent-samples t-test was conducted to assess staffing differences between the two study hospitals (Table 6). Both hospitals were overstaffed, with total actual hours of nursing care exceeding recommended hours. However, the total hours at hospital A were only slightly above recommended hours (M=

-0.16, SD= 8.5), while actual staffing at hospital B exceeded recommendations by 2.09 hours per shift (SD= 10.47). The difference was statistically significant (t = 74.34, p < .001). On average, hospital A had less actual RN staffing hours of care (M= 1.27, SD = 5.43) than recommended, while hospital B had more actual RN hours of care than recommended (M = -.34, SD = 8.44). Once again, the difference between the two hospitals was statistically significant (t=88.53, p < .001). Actual hours of care provided by NT exceeded recommendations at both hospitals; however, the difference at hospital B (M = -1.75, SD = 5.32) was greater than hospital A (M = -1.44, SD 5.47), a difference that was statistically significant (t = 20.45, p < .001).

Table 6
Staffing Differences by Hospital

Hospital	Difference in Total Recommended vs. Actual Hours	Difference in RN Recommended-to-Actual Hours	Difference in NT Recommended-to-Actual Hours
A	-0.16	1.27	-1.44
B	-2.09 t = 74.34, 363,839 df, p<0.001	-0.34 t = 88.53, 462,537 df, p <0.001	-1.75 t = 20.45, 626,837df, p<0.001

Staffing differences by unit type. A one-way analysis of variance was conducted to compare unit type with differences in recommended-to-actual nurse staffing (Table 7). There was a significant effect of unit type on the difference in total recommended-to-actual staffing [F(5, 626,838) = 9177.93, p < 0.001], the difference in RN recommended-to-actual staffing [F(5, 626,838) = 10734.86, p < 0.001], and the difference in recommended-to-actual NT staffing [F(5, 626,838) = 4086.76, p < 0.001]. With one exception, all units differed significantly from medical units for each staffing variable.

Critical care units did not significantly differ from medical units in the difference in NT recommended-to-actual hours.

Table 7

Differences in Recommended-to-Actual Staffing Hours by Unit Type

Unit Type	Difference in Total Recommended vs. Actual Hours	Difference in RN Recommended-to-Actual Hours	Difference in NT Recommended-to-Actual Hours
Medical	-.38	-.14	-.16
Surgical	-.99*	1.14*	-2.01*
Medical surgical	-1.23*	.62*	-1.81*
Moderate acuity	-6.91*	-7.21*	.46*
Step-down	-4.58*	-1.77*	-2.74*
Critical care	3.60*	3.89*	-.17
	(F = 9177.93, 5 df, $p<0.001$) η^2 = .07	(F = 10734.86, 5df, $p<0.001$) η^2 = .08	(F = 4086.68, 5df, $p<0.001$) η^2 = .03

* Significantly different from medical units at $p<0.001$

Staffing differences by shift. Differences in recommended-to-actual hours of nursing care across shifts were examined using a one-way analysis of variance (Table 8). There was a significant effect of shift on the difference in total recommended-to-actual staffing [F = 53423.456, p < .001], the difference in recommended-to-actual RN staffing [F = 47133.924, p < .001], and the difference in recommended-to-actual NT staffing [F = 11584.438, p < .001].

The total hours of actual nursing care exceeded recommended hours of care on the second shift (overstaffing) (M= -6.14 SD = 10.11) and third shift (M= -1.96, SD = 8.63). In contrast, the first shift was understaffed (M=3.38, SD=10.12). Both RN actual hours of care (M = -3.20, SD = 7.08) and NT actual hours of care (M= - 2.94, SD = 5.07) contributed equally to the differences on the second shift. However, on the third shift, NT actual hours (M = -1.67, SD = 5.48) of care were the primary driver of overstaffing.

Overall, shifts accounted for three times the variation in RN staffing differences (η^2=0.13) than NT differences (η^2=0.04).

Table 8
Differences in Recommended-to-Actual Staffing Hours by Shift

Shift	Difference in Total Recommended vs. Actual Hours	Difference in RN Recommended-to-Actual Hours	Difference in NT Recommended-to-Actual Hours
1st shift	3.38	3.79	-0.41
2nd shift	-6.14* (*F*=53423.45, 2 df, p<0.001) η 2 =0.15	-3.20* (*F*=47133.92, 2 df, p<0.001) η 2=0.13	-2.93* (F=11584.44, 2 df, p<0.001) η 2=0.04
3rd shift	-1.96*	-.30*	-1.67*

*Significantly different from 1st shift at p<0.001

Patient Falls and Unit and Patient Characteristics

Bivariate relationships between patient falls and unit and patient characteristics were assessed using a Chi-square test (Table 9). Hospital B had more falls than hospital A, although this difference was not statistically significant (x^2 =.740, p = .39). More falls occurred on the second shift (35%), followed by night shift (34%), and then the day shift (31%). Medical surgical units accounted for 48% of total falls, followed by step-down units (29%), medical units (11%), critical care units (5%), surgical units (4%), and moderate acuity units (3%). Medical units had the highest number of falls per 1,000 patient days (2.9 falls/1,000 patient days), followed by step-down units (2.2 falls/1000 patient days), medical-surgical units (2.0 falls/1,000 patient days), surgical units (1.4 falls/1,000 patient days), moderate acuity units (1.3 falls/1,000 patient days), and critical care units (0.8 falls/1,000 patient days).

Males experienced more falls (58%) than females (42%). Patients who fell were slightly older (M = 63.28, SD = 16.05) than those who did not fall (M = 62.44, SD = 17.47). Patients between the ages of 50 and 59 years had the most number of falls (n =

89, 22.5%). Gender ($x^2 = 7.66$, $p < .05$) and unit type ($x^2 = 31.933$, $p = .000$) were the only variables to reach statistical significance.

Table 9

Chi-Square Test for Patient Falls

Variable	Fall	No Fall	x^2	*p*-value
Hospital			.740	.390
A	98	167,427		
B	297	459,017		
Gender			7.66	.022
Male	228	317,982		
Female	167	308,447		
Shift			2.197	.333
1st shift	122	201,298		
2nd shift	140	200,401		
3rd shift	133	224,745		
Unit type			31.933	.000
Medical	45	47,524		
Surgical	16	34,559		
Medical surgical	191	286,143		
Moderate acuity	9	22,287		
Step-down	114	156,526		
Critical care	20	79,405		
Age Group			8.640	.280
<= 29	14	36,477		
30 - 39	17	35,291		
40 – 49	40	58,837		
50 – 59	89	118,627		
60 – 69	81	141,138		
70 – 79	83	125,277		
80 – 89	57	89,679		
>=90	14	21,118		

Patient Falls and Staffing Differences

Bivariate relationships between patient falls overstaffing and understaffing were assessed using a Chi-square test (Table 10). Neither overstaffing nor understaffing was significantly associated with patient falls.

Table 10
Chi-square Test for Patient Falls and Overstaffing and Understaffing

Variable	Fall	No Fall	x^2	*p*-value
Overstaffed				
Total	109	148,172	3.40	.065
RN	54	74,787	1.127	.288
NT	47	70,664	.151	.698
Understaffed				
Total	47	90,000	1.955	.162
RN	37	77,029	3.141	.076
NT	11	20,544	.306	.580

An independent-samples t-test was conducted to compare continuous staffing variables and patient falls (Table 11). Levene's tests for equality of variances revealed that the variability in all staffing variables between patients who fell and patients who did not fall were similar. While both groups were overstaffed, those who fell were more overstaffed (M = - 2.74, SD 9.86) than those who did not fall (M = -1.58, SD 10.02). The difference between the two groups was statistically significantly ($t = 2.32$, $p < .05$).

Similar results were found for the difference in RN recommended-to-actual staffing hours (RN-DRAS). For patients who fell, actual hours of RN care exceeded recommended hours (M= -0.91, SD 7.24). This represented 54.6 minutes of overstaffing by RNs. For patients who did not fall, actual hours of RN care were slightly lower than recommended hours (M = 0.09, SD = 7.79) and represented 5.4 minutes of understaffing by RNs. The difference in RN recommended-to-actual hours of care between patients who fell and patients who did not fall was statistically significant ($t = 2.55$, $p < .05$).

There was no significant difference in recommended-to-actual NT hours (NT-DRAS) between those who fell (M = - 1.84, SD, 5.74) and those who did not fall (M = - 1.67, SD 5.36; t = .621, p = .535).

Table 11
Staffing Differences for Patients Who Fell and Those Who Did Not Fall

	Fall M (SD)	No Fall M (SD)	p-value
T-DRAS	-2.74 (9.86)	-1.58 (10.02)	p<.05
RN-DRAS	-.91 (7.24)	.09 (7.79)	p<.05
NT-DRAS	-1.84 (5.74)	-1.97 (5.36)	p=.535

Multivariate Analysis

Regression Analysis Model 1

Controlling for other patient and unit characteristics, the difference in total recommended nursing care hours (T-DRAS) versus actual hours was not a statistically significant predictor (OR=.994, p=.565) of patient falls (Table 12). Therefore, hypothesis number one was not supported. Likewise, understaffing was not a statistically significant predictor (OR=1.084, p=.717) of patient falls. Therefore, hypothesis number two, which suggested that understaffing was associated with patient falls, was also not supported.

With respect to control variables, relative to medical units, the odds of falling were 50% lower on a surgical unit (p=.017), 28.9% lower on medical-surgical units (p=.042), 60% lower on the moderate acuity unit (p=.013), and 73.5% lower on critical care units (p<.001). Females had a 25% lower odds of falling than men (p=.006).

Table 12

Logistic Regression Results for Total Difference in Recommended-to-Actual Staffing

	Odds Ratio	S.E.	Sig.
Staffing Variables			
Total Difference in Recommended-to-Actual Hours	.994	.011	.565
Understaffing	1.084	.222	.717
Overstaffing	1.111	.184	.567
Age	1.001	.003	.617
Gender			
Male			
Female	.753	1.03	.006
Unit type			
Medical			
Surgical	.498	.292	.017
Medical-surgical	.711	.168	.042
Moderate acuity	.399	.370	.013
Step-down	.713	.181	.061
Critical care	.265	.273	.000
Shift			
1st			
2nd	1.070	.136	.620
3rd	.941	.130	.639

Regression Analysis Model 2

Controlling for other patient and unit characteristics, the difference in RN recommended nursing care hours versus actual hours (RN-DRAS) was not a statistically significant predictor (OR=.983, p=.168) of patient falls (Table 13). Likewise, RN understaffing was not a statistically significant predictor (OR=1.116, p=.643) of patient falls. Therefore, hypothesis number three was not supported.

With respect to control variables, relative to medical units, the odds of falling were 49% lower on a surgical unit (p=.022), 61.3% lower on moderate acuity units (p=.011), 60% lower on the moderate acuity unit (p=.013), and 72.5% lower on critical care units (p<.001). Females had a 25% lower odds of falling than men (p=.006).

Table 13
Logistic Regression Results for Difference in RN Recommended-to-Actual Staffing

	Odds Ratio	S.E.	Sig.
RN Difference in Recommended-to-Actual Hours	.983	.013	.168
RN-understaffing	1.116	.237	.643
RN-overstaffing	.961	.215	.853
Age	1.002	.003	.606
Gender			
Male			
Female	.754	.103	.006
Unit type			
Medical	Referent		
Surgical	.512	.292	.022
Medical-surgical	.727	.168	.058
Moderate acuity	.387	.375	.011
Step-down	.730	.180	.081
Critical care	.275	.274	.000
Shift			
1st	Referent		
2nd	1.050	.134	.716
3rd	.922	.130	.531

Regression Analysis Model 3

Controlling for other patient and unit characteristics, the difference in NT recommended-to-actual staffing (NT-DRAS) was not a statistically significant predictor (OR=1.005, p=.754) of patient falls (Table 14). Understaffing of NT was also not significant (OR=.878, p=.714), therefore, hypothesis number four was not supported.

With respect to control variables, relative to medical units, the odds of falling were 50% lower on a surgical unit (p=.02), 28% lower on medical-surgical units (p=.051), 57% lower on the moderate acuity unit (p=.021), and 73.4% lower on critical care units (p<.001). Females had a 25% lower odds of falling than men (p=.005).

Table 14

Logistic Regression Results for Difference in NT Recommended-to-Actual Staffing

	Odds Ratio	S.E.	Sig.
NT Difference in Recommended-to-Actual Hours	1.005	.015	.754
NT-understaffing	.878	.355	.714
NT-overstaffing	1.068	.218	.762
Age	1.001	.003	.639
Gender			
Male			
Female	.752	.103	.005
Unit type			
Medical			
Surgical	.507	.292	.020
Medical-surgical	.720	.168	.051
Moderate acuity	.430	.367	.021
Step-down	.758	.179	.122
Critical care	.266	.270	.000
Shift			
1st			
2nd	1.155	.127	.257
3rd	.970	.126	.808

Supplemental Analysis

The primary analysis failed to provide any support for the study hypotheses, with all staffing variables not significantly associated with patient falls. One possible explanation is that the effects of staffing were felt disproportionately under different circumstances (i.e., different units, different times). Consistent with this possibility, other studies have reported that patient falls tend to be higher on certain unit types due to the types of patients on the units and treatments provided (Ackerman et al., 2010). For example, falls on critical care units are generally lower than other units due to the fact that patients in these units are more seriously ill, require a more intense level of care, and consequently are less likely to attempt to get out of bed and attempt to ambulate, as compared to patients in other inpatient units. Similarly, the bivariate analysis in this study established that with the exception of critical care units, staffing levels generally differed between shifts for the majority of inpatient units. Since most procedures, tests, and physician interactions with patients occur during the first shift, staffing is usually higher. Conversely, the night shift tends to have the lowest staffing levels since patients are sleeping and less often undergoing diagnostic or therapeutic procedures. In this study, however, the opposite seemed to be true.

To test whether the effects of staffing on patient falls were felt differently at different times or places, the analysis was extended by examining whether this relationship differed by unit type and by shift. To do so, interaction terms for unit type and understaffing and shift and understaffing were added. Results of these analyses indicated no statistically significant difference in the risk of falling on units that were understaffed, relative to overstaffing (Tables 15-17).

Table15

Logistic Regression Results: Interaction for Unit Type and Total Understaffing

	B	S.E.	Sig.	Odds Ratio
Total Difference in Recommended-to-Actual Hours	.010	.014	.452	1.010
Total - Understaffing	-0.333	.316	.291	.716
Total - Overstaffing				
Unit type				
Medical	Referent			
Surgical	.372	.466	.424	1.452
Medical-surgical	.222	.235	.344	1.249
Moderate acuity	-0.210	.457	.644	.810
Step-down	.210	.271	.437	.1235
Critical care	-0.039	1.419	.978	.962
Total Understaff x Surgical	-0.241	.829	.771	.786
Total Understaff x Medical-surgical	.533	.403	.186	1.705
Total Understaff x Moderate Acuity	.116	1.499	.938	1.124
Total Understaff x Step-down	.333	.561	.552	1.395
Total Understaff x Critical Care	-1.63	2.001	.416	.195
Age	.006	.005	.231	1.006
Gender				
Male				
Female	-.289	.160	.071	.749
Shift				
1st	Referent			
2nd	.303	.123	.014	1.430
3rd	-.248	.134	.065	.825

Table 16

Logistic Regression Results: Interaction for Unit Type and RN Understaffing

	B	S.E.	Sig.	Odds Ratio
Difference in RN Recommended-to-Actual Hours	.007	.022	.106	.993
RN Understaffing	-.692	.342	.043	.500
RN Overstaffing				
Unit type				
Medical	Referent			
Surgical	-.805	1.414	.569	.447
Medical-surgical	-.127	.379	.739	.881
Moderate acuity	-.378	.460	.676	.685
Step-down	.261	.349	.455	1.298
Critical care	-.196	1.414	.890	.822
RN Understaff x Surgical	.927	1.572	.555	2.528
RN Understaff x Medical-surgical	.562	.532	.291	1.754
RN Understaff x Moderate Acuity	1.150	1.499	.443	3.159
RN Understaff x Step-down	.425	.584	.466	1.298
RN Understaff x Critical Care	-.856	2.001	.669	.822
Age	.000	.006	.971	1.00
Gender				
Male				
Female	-.335	.208	.107	.715
Shift				
1st				
2nd	.016	.158	.919	.901
3rd	-.137	.167	.412	.773

Table 17
Logistic Regression Results: Interaction for Unit Type and NT Understaffing

	B	S.E.	Sig.	Odds Ratio
NT Difference in Recommended-to-Actual Hours	.066	.034	.049	1.069
NT Understaffing	.121	.445	.784	1.130
NT Overstaffing				
Unit type				
Medical	Referent			
Surgical	-.103	.849	.903	.902
Medical-surgical	-.023	.358	.949	.987
Moderate acuity	.583	.850	.492	1.793
Step-down	.256	.366	.484	1.292
Critical care	1.278	1.418	.367	3.590
NT Understaff x Surgical	1.368	1.704	.422	3.928
NT Understaff x Medical-surgical	.569	.733	.438	1.766
NT Understaff x Moderate Acuity	-.611	1.677	.715	.543
NT Understaff x Step-down	1.892	.980	.053	6.639
NT Understaff x Critical Care	-2.615	2.015	.194	.073
Age	.005	.007	.466	1.005
Gender				
Male				
Female	-.611	.262	.019	.543
Shift				
1st	Referent			
2nd	.420	.179	.019	2.226
3rd	-.023	.184	.901	1.454

Similarly, no significant results were detected when understaffing was interacted with shift (Tables 18-20).   .

Table 18

Logistic Regression Results: Interaction for Shift and Total Understaffing

	B	S.E.	Sig.	Odds Ratio
Total Difference in Recommended-to-Actual Hours	-7.852	.014	.478	1.010
Total - Understaffing	-.272	.323	.399	.761
Total - Overstaffing				
Unit type				
Medical	Referent			
Surgical	.249	.398	.531	1.283
Medical-surgical	.427	.198	.031	1.534
Moderate acuity	-.223	.448	.618	.800
Step-down	.308	.239	.198	1.361
Critical care	-1.975	1.396	.157	.139
Age	.005	.004	.238	1.006
Gender				
Male				
Female	-.291	.161	.071	.747
Shift				
1st				
2nd	.243	.138	.078	1.189
3rd	-.3136	.168	.062	.681
Total Understaffing x 2nd shift	.281	.506	.579	1.324
Total Understaffing x 3rd shift	.297	.504	.555	1.346

Table 19

Logistic Regression Results: Interaction for Shift and RN Understaffing

	B	S.E.	Sig.	Exp(B)
RN Difference in Recommended-to-Actual Hours	-.008	.021	.698	.992
RN Understaffing	-.293	.389	.452	.746
RN Overstaffing				
Unit type				
Medical	Referent			
Surgical	-.403	.653	.536	.668
Medical-surgical	.089	.269	.740	1.093
Moderate acuity	-.316	.452	.484	.729
Step-down	.399	.284	.159	1.491
Critical care	-1.498	1.390	.281	.224
Age	.000	.006	.970	1.00
Gender				
Male				
Female	.340	.210	.105	.712
Shift				
1st	Referent			
2nd	.064	.182	.722	.977
3rd	-.152	.223	.493	.786
RN Understaffing x 2nd shift	-.461	.674	.494	.631
RN Understaffing x 3rd shift	-.088	.594	.882	.916

Table 20

Logistic Regression Results: Interaction for Shift and NT Understaffing

	B	S.E.	Sig.	Odds Ratio
NT Difference in Recommended-to-Actual Hours	.066	.034	.05	1.069
NT Understaffing	-.007	.631	.992	.993
NT Overstaffing				
Unit type				
Medical	Referent			
Surgical	-.051	.838	.951	.950
Medical-surgical	.095	.321	.767	1.100
Moderate acuity	.006	.827	.995	1.006
Step-down	.388	.350	.267	1.474
Critical care	-1.550	1.379	.261	.212
Age	.006	.008	.462	1.006
Gender				
Male				
Female	-.614	.265	.021	.541
Shift				
1st	Referent			
2nd	.422	.194	.029	1.919
3rd	-.192	.223	.388	1.038
NT Understaffing x 2nd shift	.035	.904	.969	1.036
NT Understaffing x 3rd shift	.971	.784	.312	2.207

CHAPTER 5

Discussion

Explanation of Findings

Falls and Staffing Differences

The purpose of this study was to examine the association between differences in recommended-to-actual nurse staffing levels when measured at the shift level as related to patient falls in hospitals. Conventional wisdom and other research suggests that greater staffing levels would contribute to fewer falls (Bouldin et al., 2013; Donaldson et al., 2005; Everhart et al., 2014; Lake et al., 2010; Lang et al., 2004). Contrary to expectations, however, this study found no association between patient falls and overstaffing or understaffing.

Several possible explanations may account for the lack of significant findings. First, with so few falls occurring during the study period, it is possible that organizational opportunities to impact falls, such as staffing, were minimal. Similarly, the findings of this study suggest that the hospitals in the sample performed relatively well in matching staffing with patient care needs. Thus, it is possible that during this time frame, the level of staffing differences was not sufficient to impact patient falls. Additionally, overall staffing levels in these hospitals were consistent with the 50^{th} percentile of other hospitals within the NDNQI. It is possible that these staffing levels contributed to the overall low fall rate.

Second, the staffing metric utilized in this study was a novel measure to examine the association between nurse staffing levels and patient falls. It is possible that this metric may be more appropriate when measured over a series of shifts versus a single point in time, similar to the method utilized in the Needleman study (2011). Specifically, repeated exposures to shifts that were understaffed may predispose a patient to attempt to ambulate without assistance if staff were slow to respond to prior requests for help.

Third, issues may have existed with respect to the timing of when the recommended staffing levels were obtained. Recommended staffing levels were measured at the start of the shift; however, staffing recommendations can change throughout the day. The recommended staffing levels could have been different at the time of the fall as compared to the beginning of the shift when the measurement was taken. If recommended levels were higher than when measured at the start of the shift, it is likely that the unit may not have been able to adjust staffing quickly enough. Once a shift has started, it becomes more difficult for nursing units to acquire more staff. Additionally, a single significant change in a patient's condition, such as a cardiac arrest, causes disruption on the unit and a high degree of focus to that one patient. As a result, requests to other patient care needs may be delayed.

Although the multivariate analysis did not yield a significant relationship between staffing differences and patient falls, the bivariate analysis did yield a number of significant relationships that may provide important insights for organizations dealing with staffing and patient falls. Patients were significantly more likely to fall during an overstaffed shift; however, the significance of this relationship disappeared when adjusting for patient and organizational characteristics. These findings emphasize the importance of considering other factors that may influence falls within the hospital and that incomplete assessments of the impact of staffing may result in equivocal conclusions and recommendations about the effect of staffing allocations.

Similar to other studies, unit type had an impact on patient falls (Dunton et al., 2004; Sovie & Jawad, 2001). Yet, when evaluating the effects of overstaffing and understaffing on patient falls by unit type there was not a significant association. These results differed from other studies that demonstrated an association between lower levels of staffing and patients falls on certain unit types (Patrician et al., 2011; Staggs & Dunton, 2014). This may be related to the fact that different measures of nurse staffing were used. Specifically, this study utilized a measure that considered patient care needs as compared to previous research studies that utilized only actual staffing levels. Further investigation into other unit attributes that may impact on patient falls should be considered.

Staffing Differences by Hospital

Staffing differences between hospitals were not unexpected. Hospital B has a case mix index that is 22% higher than Hospital A. Additionally, Hospital B is designated as a level one trauma center, has a transplant center, and is one of the busiest emergency departments in the country, admitting over 32 more patients per day, on average. In contrast, Hospital A has more routine surgical procedures that follow a normal rhythm throughout the week. Due to the *busyness* of Hospital B, including the large volume of unplanned admissions and higher patient acuity, it would not be unusual to have slight overstaffing.

The implications of these findings, however, may have negative consequences to the organization. First, staffing allocation in hospitals is difficult and challenging. Despite differences in service and case mix between the two hospitals, it is possible that staff members at Hospital A may feel slighted. This, in turn, could create tension between the two hospitals. At the same time, due to the *busyness* of Hospital B, staff members may feel overwhelmed and burdened, leading to burnout and higher rates of turnover. Second, overstaffing has a negative financial impact to the organization. Increasing erosion of reimbursement combined with greater staffing levels than anticipated in the financial plan may lead to pressures to reduce other expenses that may impact quality and other business operations.

Staffing Differences between Unit Types

All units except the critical care units were overstaffed. It is important to note that while the majority of units were overstaffed, the average difference ranged from .38 hours (22 minutes) on medical units to 6.91 hours (6 hours and 54 minutes) on the moderate acuity unit. None of the unit types, on average, was overstaffed or understaffed by what would be considered one caregiver per shift. The moderate acuity unit had the highest level of overstaffing when compared to medical units. This unit is a mixed unit that incorporates a six-bed burn center, capable of providing critical care. While the burn unit is separated by doors from the rest of the 16 step-down beds on the unit, staffing levels are occasionally inefficient. If a nurse is working in the burn unit, it is difficult for him or her to be assigned to another patient on the 16-bed step-down side of the unit. Depending on the number of patients in the burn unit, the unit may be overstaffed merely because of the design of the unit (i.e., doors, proximity to equipment). It is also possible to have no burn patients on the unit but to have other types of patients. Staff members may be accustomed to the higher staffing levels normally associated with burn patients and be reluctant to float or reduce the staffing levels.

Given the relatively low difference between recommended-to-actual staffing on medical, surgical, and medical surgical units, it is possible that the differences are the result of overtime. End of shift report, completing patient care tasks, and documentation may contribute to these extended hours. If this is the case, this finding may suggest that nurse leaders on various units should manage or control staffing differently or have different processes in place to ensure that staff members are able to complete their work by the end of the shift.

Step-down units were also overstaffed, however, the difference suggests more than casual overtime. It is possible that staff members on these units are consistently staffing above recommended levels due to a perceived need. If staff are concerned that the recommended staffing levels are insufficient and patient safety or quality may be compromised, it is possible that they will keep additional staff. It is also possible that staffing decisions are consistently made that are contrary to recommendations without guidance or oversight by management.

In this study, critical care units were understaffed. It is possible that these units were unable to meet the staffing requirements because of a lack of trained critical care nurses. On average, the orientation period for a critical care nurse is approximately four to six months. When a RN decides to leave a unit, the accepted notice is two to three weeks. This results in a period of several months in which the unit may be without adequate resources. Organizational mindfulness about unit turnover and the length of orientation for specialty units is imperative to ensure that appropriately trained nurses are available to care for patients.

Staffing Differences by Shift

Staffing variances were significantly different across all shifts. Understaffing occurred on day shift, while overstaffing was present on the second and third shifts, with the greatest overstaffing occurring on the second shift. There are several possible explanations for this phenomenon. First, there are generally more people around on the day shift, such as nurse managers, educators, and other specialists. Because of the difficulty in getting staff to work extra, non-day shift hours, it is possible that evening and night shifts are scheduled a bit heavier to ensure adequate staffing. Staff call-ins for sickness or sudden increases in patient census or acuity, contributes to the need for additional resources within hours. When these occur on the non-day shifts, securing extra staff is more challenging. As a result, scheduling practices that favor the non-day shift provides a buffer for unanticipated staffing needs.

Second, most patient discharges in this organization occurred between the hours of 1:00 p.m. and 5:00 p.m. If patient volumes drop below anticipated volumes and staff members are not sent home, then overstaffing occurs. This finding is consistent with previous studies in which more falls occurred on evening and night shifts, although the relationships were not significant (Langemo et al., 2002; Patrician et al., 2011).

Lastly, in this study, the recommended staffing levels were measured at 7:00 a.m. However, patient classification is generally completed around 10:00 a.m. While nurses were encouraged to identify changes in patient conditions throughout the day and night and enter them into the patient classification system, it is possible and likely that this was not consistently done. As a result, recommended staffing levels may have underrepresented patient care needs on the first shift.

Implications of Findings

Patient falls are a serious safety event and are of interest to hospital administrators, nurse leaders, nurses, and patients. Mounting financial pressures to reduce costs and improve quality puts nursing in the cross-hairs to increase vigilance in monitoring patients while being threatened with reductions in staff levels. While the findings, in general, did not reveal a significant relationship between nurse staffing differences and patient falls, it should be noted that these hospitals were staffed at the 50th percentile, the majority of shifts were staffed above recommended levels, and there were relatively few patient falls. Thus, the findings may not generalize to other hospitals facing similar circumstances. Even so, this is the first study to explore the relationship between nurse staffing levels and patient falls using recommended versus actual nurse staffing hours at the shift level. This study adds to the emerging literature on the use of shift-level data to evaluate nurse staffing on patient outcomes. It also contributes to the literature by utilizing a less commonly applied nurse staffing metric (i.e., recommended versus actual hours of care). In doing so, it better reflected the concept of patient churn or patient turnover that other studies have identified as a contributor to increased nursing workload. Thus, the findings from the study may be viewed as providing an important foundation on which subsequent research can be built.

These findings further suggest that to be good stewards of resources, nurse leaders may want to consider other interventions including technology and devices that may aid in the reduction of falls and improve nursing efficiencies. Staff nurses may utilize these results to examine other factors on their unit that might help to reduce falls.

Recommendations for Future Research

Future research is needed to continue to extend our current understanding of the relationship between nurse staffing and patient falls. One area of growing interest is the impact of teamwork on patient outcomes. Given similar staffing levels, might teamwork contribute to enhanced patient outcomes? That is, the ways in which nurses work together may impact patient outcomes as much as how many nurses are working. While shift level data are an enhancement to evaluating nurse staffing levels, further investigation is needed into actual nurse workloads at the time of adverse outcomes, such as falls. Because of census fluctuations throughout the day, nurse workloads will also vary throughout the day. In general, hospitals are not nimble enough to respond to changes in volume and acuity quickly. To that end, understanding the degree to which nursing workloads vary throughout the day and within shifts, as well as the impact on patient outcomes would be of interest.

Continued research is needed to examine appropriate evidence-based staffing methodologies that incorporate unit, nurse, and organizational variables. These variables would help address questions raised by many staff nurses who question the validity of patient classification tools. Such methodologies would ideally be driven from documentation within the electronic health record, thereby eliminating redundant work. Examination of patient care needs from nursing documentation as compared to existing patient classification systems would be the first step towards refining staffing projections.

The staffing metric utilized in this study, recommended versus actual staffing, warrants further investigation with regard to its potential relationship to other patient outcomes. Needleman and colleagues utilized the metric to explore mortality and evaluated repeated exposures to understaffing. Other outcomes such as hospital acquired pressure ulcers, medication errors, and central line associated blood stream infections would be important to investigate in a similar manner.

Finally, the re-examination of patient falls as a nursing sensitive indicator would be another avenue for future research. When an event is classified as a nursing sensitive indicator, it suggests that the outcome is impacted by the quantity or quality of nurses. Potential solutions might be overlooked because the semantics of this event suggest that solutions are nursing-centric. However, the multi-causality of patient falls more realistically implies a broader level of organizational engagement is needed to impact this outcome. Such an examination would surely provide for lively, scholarly debate.

Limitations

Although the sample size was sufficient, the study included only two hospitals within the same system, thereby reducing the ability to generalize the findings to other organizations. Moreover, more hospitals may have yielded greater variation with respect to staffing differences and more patient falls.

Along similar lines, falls were voluntarily reported and therefore could have been underreported. Nurses in this study were required to document falls in a separate software system and, in the midst of other patient care needs, it is possible that staff members may have forgotten to complete the document.

Another limitation of the study was potentially confounding variables that were not considered. These variables could have impacted the recommended number of nurses. For example, environmental factors such as the size of patient rooms, semi-private versus private room accommodations, and the design or layout of the unit could affect the distance that staff members needed to walk to provide care. If staff members had to walk further between patients, it would have affected their ability to respond quickly to patient care needs.

Also, differences in nurse demographics such as educational level, certification, and experience were not considered in the study. As a result, all nurses were considered equal in terms of their capabilities to deliver care, despite research that has shown that less experienced staff members are associated with more negative patient outcomes (Friese, Lake, Aiken, Silber, & Sochalski, 2008)

Summary

Patient falls are a significant safety issues in hospitals. Preventative strategies to reduce falls are important to hospitals, providers, and nursing staff as well as patients. As hospitals face mounting financial pressures to reduce patient harm it is imperative that evidenced-based staffing solutions be considered. Nurse staffing is a key component in hospitals, and understanding the most effective and efficient use of staff to minimize harm is imperative.

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APPENDIX A

NURSING-SENSITIVE INDICATORS

(American Nurses Association)

- Nursing Hours per Patient Day
    - Registered Nurses (RN) Hours per Patient Day
    - Licensed Practical/Vocational Nurses (LPN/LVN) Hours per Patient Day
    - Unlicensed Assistive (NT) Hours per Patient Day
- Nursing Turnover
- Nosocomial Infections
    - Catheter associated urinary tract infection
    - Central line associated blood stream infection
    - Ventilator-associated pneumonia
- Patient Falls
- Patient Falls with Injury
    - Injury Level
- Pressure Ulcer Rate
    - Community-acquired
    - Hospital-acquired
    - Unit-acquired
- Pediatric Pain Assessment, Intervention, Reassessment (AIR) Cycle
- Pediatric Peripheral Intravenous Infiltration
- Psychiatric Physical/Sexual Assault
- RN Education/Certification
- RN Survey
    - Job Satisfaction Scales
    - Practice Environment Scale (PES)
- Restraints
- Staff Mix
    - RN
    - LPN/LVNs
    - NT
    - Percent Agency Staff

Source:
http://www.nursingworld.org/MainMenuCategories/ThePracticeofProfessionalNursing/PatientSafetyQuality/Research-Measurement/The-National-Database/Nursing-Sensitive-Indicators_1

APPENDIX B

ACUITY PLUS INDICATOR DEFINITIONS

1. ADL – self/minimal care: Select for a patient who independently performs activities of daily living or needs minimal assistance to manage the environment and/or medical/therapeutic devices.
2. ADL – partial care: Select for a patient who requires assistance in performing any activity of daily care.
3. ADL – extended assist: Select for a patient who requires frequent assistance in performing activities such as toileting or a patient that requires assistance with four or more activities (feeding, bathing, toileting, mobility, or dressing).
4. ADL – complete care: Select for a patient who is dependent on staff for all activities of daily living.
5. ADL – rehabilitative: Select for a patient who requires assessment and intervention to restore/achieve the highest level of ADL attainable. Staff is working with the patient in a cognitive manner, helping the patient achieve a higher level of independence.
6. ADL assistance – 2-3 caregivers: Select for a patient who requires two or three caregivers to complete any activity of daily living.
7. ADL assistance – 4 or more caregivers: Select for a patient who requires four or more caregivers to complete any activity of daily living.
8. Communication support: Select for a patient who requires additional care due to uncompensated vision, hearing, speech deficits, language barriers or limitations related to literacy. May apply if the additional care is provided to the patient's family or significant other.

9. Cognitive support: Select for a patient who, due to temporary or permanent limitations or alterations in cognitive functioning, requires an assessment and intervention to orient to person, place or situation.
10. Behavioral/emotional management: Select for a patient who requires intervention to manage behavior or emotions to maintain/regain the ability to participate in the plan of care. May apply if the intervention is provided to the patient's family or significant other.
11. Behavioral/emotional management – every one hour: Select for a patient who requires intervention to manage behavior or emotions to maintain/regain the ability to participate in the plan of care every one hour or more often for the majority of the classification period. May apply if the intervention is provided to the patient's family or significant other.
12. Safety management – every two hours: Select for a patient who, due to risk to harm self or others, requires observation and/or intervention by a staff member every two hours or more often for the majority of the classification period.
13. Safety management – every 30 minutes: Select for a patient who, due to risk to harm self or others, requires observation and/or intervention by a staff member every 30 minutes or more often for the majority of the classification period.
14. Isolation precautions (transmission-based): Select for a patient who, due to known or suspected risk for transmissible infection or susceptibility to transmissible infection, requires additional precautions beyond standard precautions. This includes airborne, droplet and/or contact isolation.

15. Physiological assessment – every four hours: Select for a patient who requires physiological assessment and/or intervention every four hours or more often for the majority of the classification period.
16. Physiological assessment – every two hours: Select for a patient who requires physiological assessment and/or intervention every two hours or more often for the majority of the classification period.
17. Physiological assessment – every one hour: Select for a patient who requires physiological assessment and/or intervention every one hour or more often for the majority of the classification period.
18. Physiological assessment – every 30 minutes: Select for a patient who requires physiological assessment and/or intervention every 30 minutes or more often for the majority of the classification period.
19. Vascular access site management – every one hour: Select for patient who, due to age, mobility or risk of extravasation, requires assessment of an IV site every one hour or more often for at least a 12 hour duration.
20. Medication preparation – greater than 20 minutes: Select for a patient who requires preparation of medication(s) or preparation to administer medication(s) requiring 20 minutes or greater of continuous staff time.
21. Wound/injury management: Select for a patient who requires an assessment and/or intervention of a wound/injury site.
22. Wound/injury management – greater than 30 minutes: Select for a patient who requires continuous wound/injury site intervention for 30 minutes or greater.

23. Healthcare management education – greater than one hour: Select for a patient who requires individualized education of one hour or greater cumulative duration to address the knowledge and/or procedures that will be necessary for post-discharge healthcare management. A current plan with objectives for teaching/learning exists, and the patient is able to understand and respond to the education. May apply to the patient's family, caregiver or significant other.
24. One to one physiological intervention – greater than two hours: Select for a patient who, due to physiological instability, requires continuous 1:1 or greater RN assessment and/or intervention at the bedside for two hours or greater.

APPENDIX C

UNIT TYPES BY HOSPITAL

Type	Unit	Hospital	Specialty
Medical	1D		
Surgical	3E	A	Orthopedics
	3G	A	Orthopedics
Medical surgical	1E	A	
	2S	B	
	3H	A	
	4G	A	
	4H	A	
	4N	B	
	4S	B	
	4W	B	
	5N	B	
	5S	B	
	7N	B	
	7S	B	
Moderate Acuity	6S	B	
Step-down	1G	A	Medical step-down
	6MHC	B	Cardiac step-down
	6N	B	Medical step-down
	7MHC	B	Surgical step-down
Critical Care	1H	A	
	4MHCW	B	Neuro sciences ICU
	4MHCE	B	
	5MHCE	B	Cardio-thoracic ICU
	5MHCW	B	Medical ICU

APPENDIX D

INSTITUTIONAL REVIEW BOARD APPROVAL FROM
THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

Form 4: IRB Approval Form
Identification and Certification of Research
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on January 24, 2017. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

Principal Investigator:	ULREICH, SHAWN
Co-Investigator(s):	
Protocol Number:	**X141211007**
Protocol Title:	*Variance in Recommended to Actual Nurse Staffing and Patient Falls*

The IRB reviewed and approved the above named project on 12-19-14. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.

IRB Approval Date: 12-19-14

Date IRB Approval Issued: 12-19-14

IRB Approval No Longer Valid On: 12-19-15

HIPAA Waiver Approved?: Yes

Marilyn Doss
Member - Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

470 Administration Building
701 20th Street South
205.934.3789
Fax 205.934.1301
irb@uab.edu

The University of
Alabama at Birmingham
Mailing Address:
AB 470
1720 2ND AVE S
BIRMINGHAM AL 35294-0104

THE UNIVERSITY OF
ALABAMA AT BIRMINGHAM
Institutional Review Board for Human Use

PI: ULREICH, SHAWN
Protocol # X141211007

UAB IRB Approval of Waiver of Informed Consent and/or Waiver of Patient Authorization

☑ **Approval of Waiver of Informed Consent to Participate in Research.** The IRB reviewed the proposed research and granted the request for waiver of informed consent to participate in research, based on the following findings:

1. The research involves no more than minimal risk to the subjects.
2. The research cannot practicably be carried out without the waiver.
3. The waiver will not adversely affect the rights and welfare of the subjects.
4. When appropriate, the subjects will be provided with additional pertinent information after participation.

Check one:
☑ **and** Waiver of Authorization (below)
☐ **or** Waiver of Authorization (below)
☐ Waiver of Authorization not applicable

☑ **Approval of Waiver of Patient Authorization to Use PHI in Research.** The IRB reviewed the proposed research and granted the request for waiver of patient authorization to use PHI in research, based on the following findings:

1. The use/disclosure of PHI involves no more than minimal risk to the privacy of individuals
   i. There is an adequate plan to protect the identifiers from improper use and disclosure.
   ii. There is an adequate plan to destroy the identifiers at the earliest opportunity consistent with conduct of the research, unless there is a health or research justification for retaining the identifiers or such retention that is otherwise required by law.
   iii. There is an assurance that the PHI will not be reused or disclosed to any other person or entity, except as required by law, for authorized oversight of the research study, or for other research for which the use or disclosure of PHI would be permitted.
2. The research cannot practicably be conducted without the waiver or alteration.
3. The research cannot practicably be conducted without access to and use of the PHI.

—OR—

☐ **Full Review**
The IRB reviewed the proposed research at a **convened meeting** at which a majority of the IRB was present, including one member who is not affiliated with any entity conducting or sponsoring the research, and not related to any person who is affiliated with any of such entities. The waiver of authorization was approved by the majority of the IRB members present at the meeting.

Date of Meeting

Signature of Chair, Vice-Chair or Designee

Date

☑ **Expedited Review**
The IRB used an **expedited review procedure** because the research involves no more than minimal risk to the privacy of the individuals who are the subject of the PHI for which use or disclosure is being sought. The review and approval of the waiver of authorization were carried out by the Chair of the IRB, or by one of the Vice-Chairs of the IRB as designated by the Chair of the IRB.

12-19-14
Date of Expedited Review

Marilyn Doss
Signature of Chair, Vice-Chair or Designee

Date 12-19-14

Rev. 12/08/2005

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Page 1 of 1

APPENDIX E

INSTITUTIONAL REVIEW BOARD APPROVAL FROM SPECTRUM HEALTH

SPECTRUM HEALTH
Human Research Protection Program
Office of the Institutional Review Board
100 Michigan NE, MC 038
Grand Rapids, MI 49503
616.486.2031
irb@spectrumhealth.org
www.spectrumhealth.org/HRPP

NON HUMAN RESEARCH DETERMINATION

December 12, 2014

Shawn Ulreich MSN, RN
Spectrum Health
100 Michigan St. NE
MC005
Grand Rapids, MI 49503

SH IRB#: **2014-282**

PROTOCOL TITLE: **Variance in Recommended to Actual Nurse Staffing and Patient Falls**

Dear Ms. Ulreich,

On December 12, 2014, the above referenced project was reviewed. It was determined that the proposed activity is research but is *not* considered to be human research because it does not meet the definition of human subjects as defined by DHHS or FDA regulations.

Therefore, approval by Spectrum Health IRB is not required. This determination applies only to the activities described in the IRB submission and does not apply if changes are made. If changes are made and there are questions about whether these activities are research involving human subjects, please submit a new request to the IRB for a determination.

The IRB has made the following determination:

- **WAIVER OF HIPAA AUTHORIZATION**: A waiver of HIPAA authorization has been approved per 45 CFR 164.512(i)(2)(ii).

Your project will remain on file with the Office of the IRB, but only for purposes of tracking research efforts within the Spectrum Health system. If you should have questions regarding the status of your project, please contact the Office of the IRB at 616-486-2031 or email irb@spectrumhealth.org.

Sincerely,

Jeffrey Jones MD
Chair, Spectrum Health IRB