THE RELATIONSHIP OF NURSE STAFFING IN ACUTE CARE HOSPITALS ON 30-DAY READMISSIONS IN AN ERA OF PAY FOR PERFORMANCE

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Abstract

Provisions of the 2010 Affordable Care Act have placed hospitals in the center of financial accountability for reducing readmissions on key conditions and have heightened interest in identifying system-level interventions for improvement. Nurses are the frontline staff for providing many of the core care processes aimed at preventing readmissions. Hospital nurse staffing levels are an important work environment issue for nurses and understood to be a determinant of the quality of nursing care and patient outcomes. Budget costs associated with nurse staffing levels combined with movement from fee-for-service to payment on outcomes have added to the complex financial and practice environment. Mounting evidence links nurse staffing to patient outcomes, which are now associated with penalties under the Affordable Care Act pay-for-performance programs.

The purpose of this descriptive correlational study was to determine the effects of acute care nurse staffing on readmissions within 30 days of hospital discharge among patients diagnosed with pneumonia, acute myocardial infarction, heart failure, chronic obstructive pulmonary disease, and elective total hip and knee arthroplasty during their index hospitalization.

The Quality Health Outcomes Model provided the theoretical foundation. Vizient data from calendar year 2016 includes de-identified hospital-level and unit-level measures as well as patient-level discharge abstracts. The study included a cross-sectional sample of 42,876 patient discharge encounters from 30 nonprofit academic medical centers and integrated hospital systems across the U.S. that are participating members of Vizient (a voluntary alliance and network). There were three general phases of substantive analysis: a descriptive (univariate) analysis of each variable in the data set, a bivariate analysis to examine how the patient and hospital characteristics relate to readmissions, and a multilevel logistic regression analysis to test the research hypothesis that adult patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days, controlling for hospital characteristics and patient characteristics.

Study findings showed that acute care hospital nurse staffing levels were associated with patient readmissions. Although hospitals with higher nursing hours per patient day (NHPPD) levels had lower readmissions within seven days of index discharge, higher nurse staffing levels were associated with greater odds for readmissions within 30 days when controlling for patient and hospital characteristics. These findings are paradoxical and suggest that there are multiple complex interrelationships interacting simultaneously that affect hospital readmissions. Staffing adequacy is essential for high quality patient care. Hospital reporting of productive, direct-care hours that are standardized with delineation between non-licensed and licensed staffing should be encouraged for consistent measurement comparison. Future studies are needed to expand knowledge on the relationship of nurse staffing levels on patient readmissions to inform nursing practice, health care organizations, and research because of the potential benefit to patient outcomes and inform financial decisions.

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Despite her young age and health challenges she greeted each day with grit and persistence to partially recover from a life-threatening acute illness. In caring for her while addressing her health and welfare challenges, I realized my passion, desire, and ability that led to my doctoral journey. I am forever the better person for having had her in my life, if even for a few short years.

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CHAPTER 1

INTRODUCTION

As many as one in four Medicare patients experiences an unplanned readmission within 30 days of hospital discharge (Jencks, Williams, & Coleman, 2009; Jha, Orav, & Epstein, 2009; Joynt & Jha, 2011; “New HHS Data”, 2014). The economic costs associated with these readmissions are estimated to range between $12-17 billion annually (Jencks et al., 2009). Some readmissions are unavoidable because of expected progression of disease or worsening of chronic disease. However, some readmissions are avoidable. Avoidable readmissions typically are the result of poor quality of care, such as inadequate discharge planning and insufficient patient and family education or readiness for discharge (Jencks et al., 2009; Stone & Hoffman, 2010; Weiss, Yakusheva, & Bobay, 2011).

Under the 2010 Affordable Care Act (ACA), hospital readmission reductions have been singled out as an important way to improve both the quality of care and lower health care spending (Stone & Hoffman, 2010). Although introduction of financial penalties for publicly reported readmissions has been highly debated, acute care hospitals now have financial accountability to reduce readmission rates (Axon & Williams, 2011; Kahn et al., 2015). The Hospital Readmission Reduction Program (HRRP), mandated by the ACA, requires the Center for Medicare and Medicaid Services (CMS) to reduce payments to acute care hospitals with excess readmissions (CMS, n.d.).

Because of this key financial implication, hospital leaders have paid more attention to patient readmissions and to the public reporting of hospital readmission rates on the Hospital Compare website (medicare.gov). Hospital leaders also have made efforts to identify system-level reasons that contribute to avoidable readmissions, especially among CMS-targeted conditions. Evidence is mixed on system-level interventions targeting comprehensive discharge planning and care transition programs, which are costly and further fragment staffing resources (Jack et al., 2009; Peikes et al., 2009). Nurse staffing and workload are part of a complex matrix of factors that contribute to hospital outcomes (Unruh, 2008). Less research has been done on how inpatient nurse staffing (which all patients are exposed to) is associated with readmissions. Adequate levels of nurse staffing may be one of the system-level strategies to reduce readmissions and avoid costly HRRP penalties and the negative marketing influences from publicly reported readmission rates specific to CMS-targeted conditions (Everhart et al., 2013; Ma, McHugh, & Aiken, 2015; McHugh, Berez, & Small, 2013; Pappas, 2008).

Problem Statement and Significance

Registered nurses are the largest component of the health care workforce representing over 20 percent of all U.S. health care workers (National Academy of Medicine [NAM], 2016; Page, 2004). Nurses are employed in a variety of settings. Many of the employment settings are in hospitals, where nearly 60 percent of nurses are employed and are engaged in all aspects of hospital care (AACN, n.d.; NAM, 2016; Page, 2004). Nurses provide preventive, primary, acute and chronic care for sick and injured patients through health information, restorative care, medication administration and emergency care. Fundamental nursing care focuses on protecting and promoting the patient’s physical and mental health through surveillance for early detection of patient complications, and upon diverse care needs, explaining procedures, and preventing complications and adverse events (Clark & Aiken, 2003; Kutney-Lee, Lake & Aiken, 2009). Nurses also provide discharge preparation for self-care, instruction for medication administration, and help with coordination of care. Previous studies have shown that patients in response to receiving high quality nursing care during their hospital stays and during the transition to non-acute settings (e.g., home) were likely to have improved outcomes such as survival, functional ability, and quality of life as well as reduced rehospitalizations (Aiken et al., 2008; Cho, Ketefian, Barkauskas, & Smith, 2003; Weiss et al., 2011).

These fundamental nursing care processes in acute care settings can be disrupted when nurses have an overwhelming workload, inadequate resources, and poor integration throughout the hospital's decision-making structure. Nurses who work in well-staffed hospitals have the time and the resources to provide better fundamental care and more effectively monitor for complications and other patient care needs that in turn may influence readmission risks (Jones, Hamilton, & Murry, 2015; Ma et al., 2015; McHugh et al., 2013). Nurses function in myriad of roles and carry out interventions both prescribed by other providers to treat illness and complications but also nurse-initiated interventions to promote health and manage patient responses to illness (Jones et al., 2015). Decades of research have shown that better nurse staffing in hospitals is associated with improved performance on various quality measures, including mortality, failure to rescue, patient satisfaction, a range of improved disease conditions and patient safety indicators such as nosocomial infections, decubitus ulcers, and falls (Aiken et al., 2002, 2008, 2014; Clarke & Donaldson, 2008; Joynt & Jha, 2011; Kane, Shamliyan, Mueller, Duval & Wilt, 2007; Needleman et al., 2002; Shekelle, 2013; Unruh, 2008; Van Bogaert et al., 2014).

Nurse labor costs in hospital settings are included in the overall hospital operations budget for patient care. Although hospital care of patients is provided primarily by nurses and the value of these services is considerable, current reimbursement models ignore the specific, unique services provided by nurses because they are hidden as part of hospital room and board charges (Aiken, 2008; Jones, et al., 2015; Kavanagh et al., 2012). Unprecedented changes in reimbursements from the ACA, along with simultaneous efforts to improve patient outcomes, quality of care, and care efficiency have led hospital leaders to seeking ways to reduce costs. Because nursing labor costs represent 50 percent or more of most hospital expense budgets, adjusting for nurse staffing is a potential source of cost savings in the presence of hospital financial and market pressures created under the ACA (Pappas, 2007, 2008). Hence a paradox; nursing practice is not revenue producing, yet nursing care drives the overall quality and safety essential to hospital success (Aiken, 2008; NAM, 2016; Pappas, 2007, 2008).

Maximizing economic returns that benefit multiple stakeholders increasingly is important, especially as the number of targeted conditions included in the HRRP continue to grow (Dall et al., 2009; McHugh et al., 2013). Budget costs associated with nurse staffing levels combined with the movement from fee-for-service and episodic payment to payment on outcomes, has propelled financial uncertainty for hospital systems (Pappas, 2008). Payment in the traditional model of health care delivery was based on the number of visits and tests ordered because of medical necessity. In the ACA era of pay for performance, fee-for-service reimbursements remain, but now center on better care at a lower cost (value-based) in an effort to improve financial alignment between hospitals, payers, and patients. For hospitals that are unable to achieve these value-based goals, the financial penalties and lower reimbursements afforded under the ACA may create financial burdens previously not experienced. Given these hospital financial pressures, nurses are at risk for inadequate support, both in staffing numbers and skill mix (Kavanagh, et al., 2012; Pappas, 2008). Maintaining adequate nurse staffing levels in this complex financial environment continues to be a challenge for hospitals.

The ACA payment reform has the potential to improve the business case for investments in nursing (Aiken, 2008). For example, hospitals investing in additional nursing staff as an improvement intervention could realize a financial return on their investment by avoiding readmission penalties (Aiken, 2008; Dall et al., 2009; Kavanagh et al., 2012; Needleman, 2008; Weiss, 2011). However, any benefits from incremental changes in nurse staffing will depend upon the staffing levels at the time of change. As such, hospitals with initially low staffing levels may experience a higher economic return from higher nurse staffing levels (Dall et al., 2009; Weiss, 2011).

Relatively few studies have examined the relationship between hospital nurse staffing and financial outcomes (Martsolf et al., 2014). Researchers have found that quality of care and patient outcomes are highly dependent on nurse staffing levels and skill mix (Cimiotti, Aiken, Sloane, & Wu, 2012; Jones et al., 2015; Kavanagh et al., 2012; Ma et al., 2015; Martsolf et al., 2014; McHugh et al., 2013). Furthermore, some of these researchers concluded that quality of care can be improved at no additional costs through use of increased staffing levels and skill mix (Ma et al., 2015; Martsolf et al., 2014). Evidence suggests that while increased nurse staffing levels might increase labor-related patient care costs, these additional nursing labor costs might offset costs associated with 30-day readmission pay for performance (P4P) penalties by reducing avoidable readmissions (Ma et al., 2015, Martsolf et al., 2014; McHugh et al., 2013).

The American Association of Colleges of Nursing (AACN), in a 2006 position statement on nursing research, endorsed the significance of nursing research pertaining to health systems and outcomes. Professional nursing care is a vital component of the health care system and the respective outcomes are particularly relevant in a value-based system (Everhart et al., 2013; Jones et al., 2015; Pappas, 2008). In a value-based environment, investments in efficient and effective operations to eliminate quality defects will convert into lower costs directly to the hospital (not the payer). Nurses are in key positions to respond to growing expectations related to the delivery of care and the influence on efficiency. As pressure mounts to better manage health care costs, efforts to improve efficiency and effectiveness of the health care system must consider nurses' contribution to ensuring cost-effective, high-quality care (Dall et al., 2009; Jones et al., 2015; Kavanagh et al., 2012).

Although many researchers have investigated the relationship between nurse staffing and adverse patient outcomes and mortality, there is little empirical evidence describing the relationship between nursing staffing and 30-day readmissions on CMS-targeted conditions, i.e., pneumonia, heart failure, acute myocardial infarction, chronic obstructive pulmonary disease, and elective total hip and knee arthroplasty (Ma et al., 2015; McHugh & Ma 2013). Understanding how hospital nurse staffing impacts patient readmission outcomes can help inform hospital leaders about the value of additional investments in nursing and the consequences of reduced investments in nursing. With more evidence about the effects of nurse staffing levels, hospital leaders would be positioned to make a business case for strategic investments in nursing. Healthcare providers assume fiscal and principled responsibility for providing the best care possible for each patient, which makes understanding system-level factors related to readmission an imperative for healthcare providers. Therefore, the purpose of this study was to examine the effects of nurse staffing on 30-day readmissions for the CMS-targeted conditions. The findings are important to nursing practice, health care organizational leaders, and research because of the potential to benefit patient outcomes and inform financial decisions.

Study Purpose

Hospital readmissions are prevalent and costly. Growing scrutiny to reduce readmission rates has placed hospitals at the center of readmission prevention (Joynt & Ja, 2011; Ma et al., 2015; Thompson, Waters, Kaplan, Cao & Bazzoli, 2017). The HRRP under the ACA has driven efforts to reduce readmissions simultaneously to lower costs and improve care quality (Stone & Hoffman, 2010). Increased hospital financial accountability under the HRRP has heightened hospital leaders' interest in identifying system-level strategies for improving readmission rates (Ma et al., 2015; Martsolf et al., 2014; McHugh & Ma, 2013; Thompson et al., 2017).

Nurses are the frontline staff for providing many of the core care processes aimed at preventing readmissions. Despite decades of evidence demonstrating the critical role that nurses play in health care delivery, little is known about the relationship between hospital nurse staffing and 30-day readmissions. Previous research on reducing readmissions has focused on disease-specific interventions and has been narrowly targeted to a subset of the population; however, the findings vary by study and by surgical versus medical patients (Ma et al., 2015; McHugh & Ma, 2013; Peikes et al., 2009). For example, 15 randomized trials of a care coordination program for elderly patients with congestive heart failure, coronary artery disease and diabetes determined that while some aspects of care were improved with targeted in-person contact overall the intervention programs were unable to demonstrate cost savings (Peikes et al., 2009). Jones and colleagues (2016), in a systematic review of three randomized clinical trials and seven observational surgical cohort studies on hospital readmissions concluded improved discharge planning, patient education, and follow-up communication were effective in reducing readmissions.

In the few studies that have examined the association between nurse staffing and readmissions, researchers have found that patients were significantly at lower risk for 30-day readmissions when cared for in hospitals with higher nurse staffing; those hospitals were less likely to be financially penalized under the HRRP (McHugh et al., 2013; McHugh & Ma, 2013; Weiss et al., 2011). However, those studies have focused on pneumonia, heart failure, and acute myocardial infarction readmissions for elderly patient populations using CMS data (McHugh et al., 2013; McHugh & Ma, 2013; Weiss et al., 2011). Therefore, attention to the structural characteristics of hospital nursing, specifically nurse staffing, has the potential to impact readmission outcomes among the six CMS-targeted conditions and other hospitalized patients.

The purpose of this study was to examine the relationship between nurse staffing and 30-day readmissions for six CMS-targeted conditions. The following hypothesis was tested in this study:

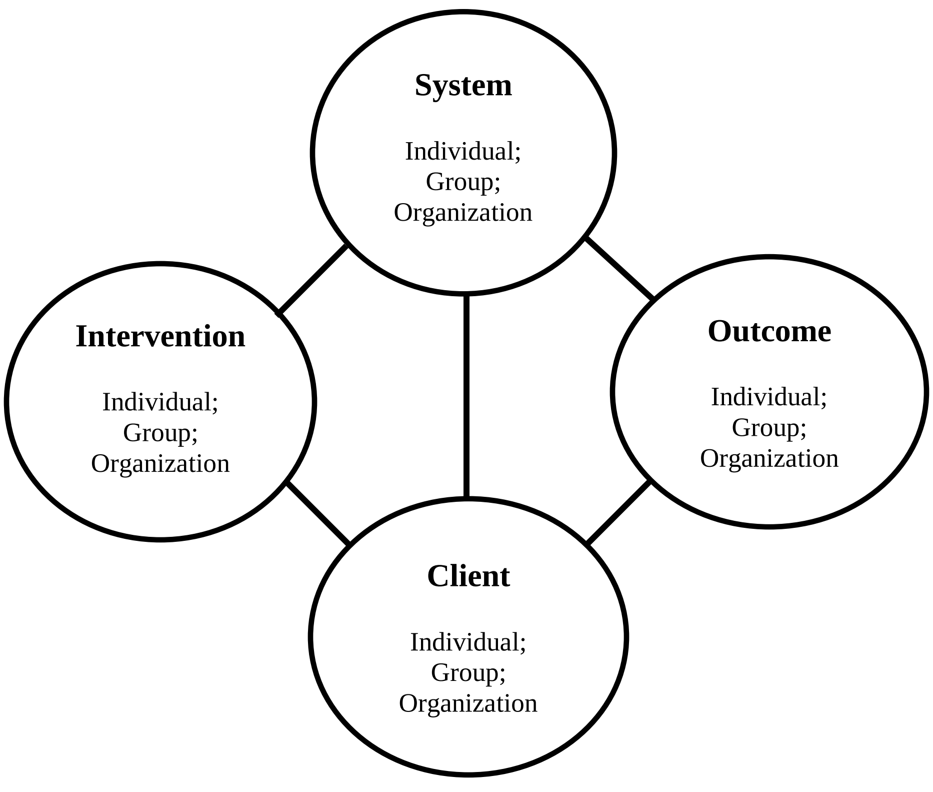
> Adult patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days, controlling for patient and hospital characteristics.

Theoretical Foundation

The Quality Health Outcomes Model (QHO, see Figure 1.1) was used as the theoretical foundation for this study. The QHO Model emerged from the Donabedian's Quality Model and describes the relationships between four concepts: system, intervention, client, and outcome (Mitchell et al., 1998). In the QHO model, the system represents structural elements, intervention is the processes of care, client represents characteristics of the individual or group, and outcomes are the results from the care delivered.

The structure-process-outcome model developed by Donabedian (1988) has commonly been used to guide evaluation of health care quality. The implied relationships among the structure-process-outcomes components are usually linear and consecutive, with each affecting the succeeding component: (a) structure, representing environmental aspects such as human resources and organizational structure; (b) process, indicating complex activities of patients seeking care and health care providers carrying out treatment and care; and (c) outcomes,

Figure 1.1 Quality Health Outcomes Model.



Mitchell, P.H., Ferketich, S., & Jennings, B.M. (1998).

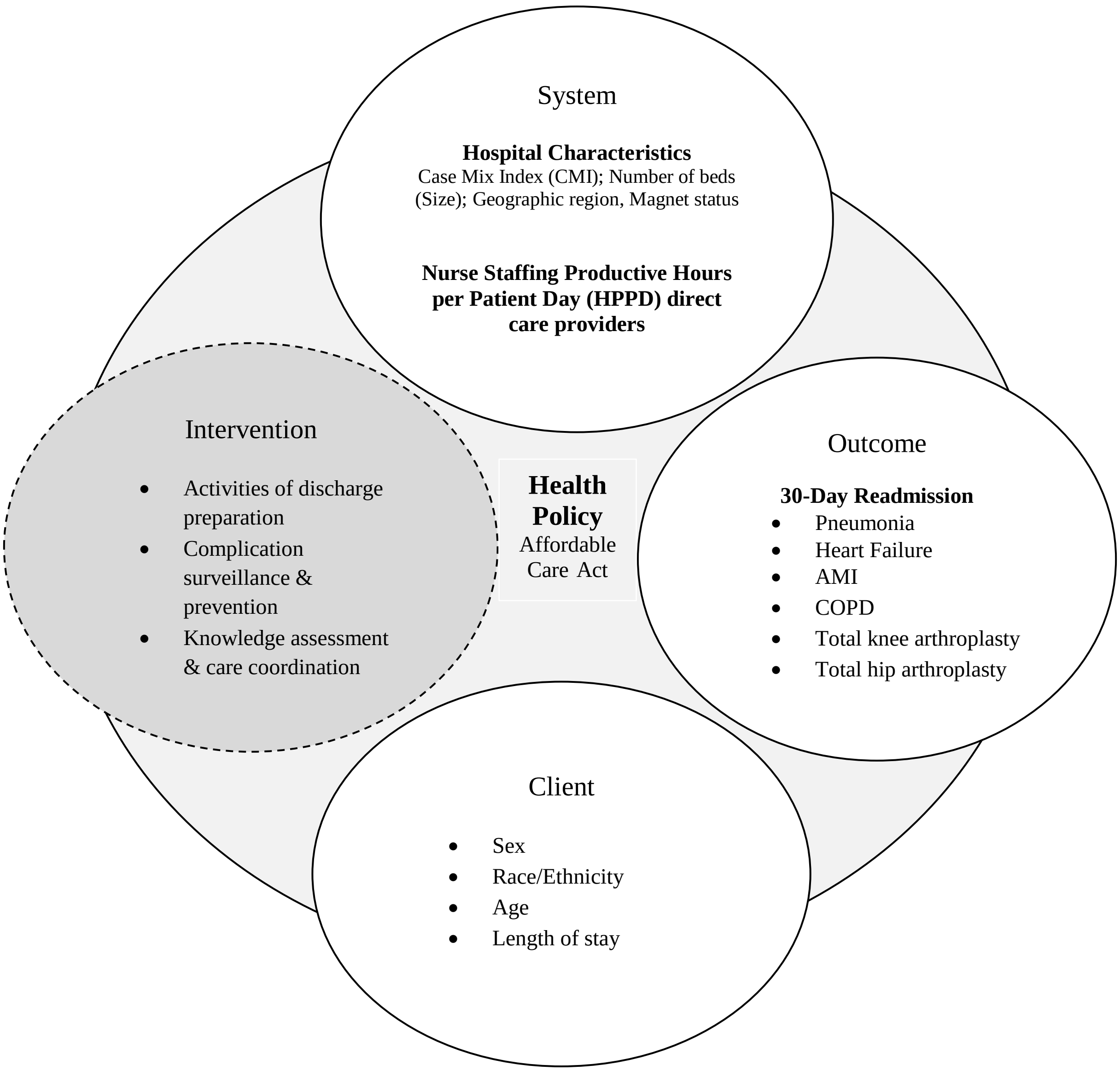
incorporating patient's knowledge improvement and satisfaction with care as well as clinical outcomes (Donabedian, 1988; Mitchell et al., 1998). However, the linear and unidirectional nature of Donabedian's structure-process-outcomes model may not reflect as accurately the complexities of health care delivery (Mitchell et al., 1998) especially when compared to the QHO model.

Unlike the traditional Donabedian model used in appraising quality, the QHO model contains complex relationships of reciprocal interaction between concepts to represent more closely the interrelationships in health care delivery (Mitchell et al., 1998). This complexity allows researchers to test more readily relationships, including patient outcomes that are sensitive to nursing interventions and system characteristics. This has made the QHO model a useful theoretical model among health services nurse researchers (Mitchell & Lang, 2004).

The QHO model incorporates the structure-process-outcomes framework into a dynamic model that recognizes the reciprocal relationship occurring among clients, the system, and interventions that link to affect outcomes (Mitchell et al., 1998). In the current study, data from one year were analyzed cross-sectionally. Because feedback loops cannot be tested in this design, the QHO model's reciprocal relationships was not examined in this study. The primary interest for this study focused on a link between structure and outcomes to examine nurse staffing levels on readmissions within 30-days of the index hospital discharge (see Figure 1.2).

In the QHO model, *System* describes a range of organizational attributes, such as nurse staffing and hospital characteristics. In this study, multiple system attributes were examined. The primary predictor of interest was nurse staffing (staffing hours per patient days). Hospital characteristics included: case mix index, size, geographic region, and Magnet® status. The

Figure 1.2 Theoretical Foundation based on the Quality Health Outcomes Model.



System concept is related to the other three concepts (i.e., *Intervention*, *Client,* and *Outcomes*) to demonstrate how features in one area are reciprocally related to features in another area. The ACA health policy is an underlying influence on each concept, and to the interrelationships of nurse staffing (*System*) on 30-day readmissions (*Outcomes*) with the patient (*Client*) and hospital (*System*) characteristics.

In general, the intervention concept included the care that nurses provide to patients. Although the *System* and *Client* concepts are related to the *Intervention* concept, the *Intervention* concept was not explored in this study. The concept of *Client* (or patient) was conceptually defined as the person receiving the care intervention but could also be the family or support person receiving the care. Used as covariates, client characteristics of interest for this study included patient age, sex, race, and length of stay during the index (baseline) admission. The care outcome of interest for this study was 30-day readmissions in patients with a primary diagnosis from the index hospitalization of: pneumonia, acute myocardial infarction, congestive heart failure, chronic obstructive pulmonary disease, total hip arthroplasty, and total knee arthroplasty. The concept of *Outcomes* to *System* was not explored in this study, but has important implications for future research related to readmissions. Given implementation of pay-for-performance programs under the ACA, patient outcomes (i.e., 30-day readmissions) will result in either monetary rewards or penalties to hospital systems based on the positive or negative outcome.

Although not tested in the current study, the interrelationship between the *System* and *Client* illustrates that the two concepts act as mediators and moderators of the effect of the *Intervention* on the clinical outcome (Mitchell & Lang, 2004). Thus, the *System* and the *Client* never operate independently of the other. The *System* explains part of the relationship between the *Intervention* and the *Outcome*. For studies that evaluate quality and system interventions to improve care, the QHO model aligns with the focus on the relationship between *System*, *Client*, and *Outcome* in this study.

Specific Aims

This study had three specific aims:

Aim1: To describe readmission rates within 30 days from index discharge and describe the actual time for the readmissions among adult patients with a primary diagnosis of the five CMS-targeted conditions (acute myocardial infarction, pneumonia, congestive heart failure, chronic obstructive pulmonary disease, elective total hip & knee arthroplasty) using the 2016 Vizient (formerly University Health System Consortium) data. To achieve Aim 1, two research questions (RQ) were asked:

RQ1. What were the readmission rates within 30 days from hospital discharge for CMS-targeted conditions of interest and in total of combined targeted conditions?

RQ2. What was the length of time between patients' index hospital discharges and readmissions within 30 days for the CMS-targeted conditions of interest?

Aim2: To examine whether patient and hospital characteristics were associated with readmissions within 30 days among the CMS-targeted conditions, controlling for nurse staffing, patient, and hospital characteristics. To achieve Aim 2, two research questions (RQ) were asked:

RQ3. What were the patient demographic characteristics (i.e., sex, race/ethnicity, age, and length of index hospital stay) for the CMS-targeted conditions of interest and the combined targeted conditions?

RQ4. What hospital characteristics (i.e., case mix index, hospital size, geographic region (Mid-Atlantic, Mid-Continent, Midwestern, New England, Southeastern, and Western), and Magnet® status) were associated with readmissions within 30 days?

Aim3: To examine whether acute care hospital nurse staffing (i.e., hours per patient day) was associated with readmissions within 30 days for adult patients with a primary CMS-targeted condition of: acute myocardial infarction, pneumonia, congestive heart failure, chronic obstructive pulmonary disease, elective total hip arthroplasty, and elective total knee arthroplasty. For this aim, continuous as well as interquartile ranges of nurse staffing were used to examine the association with readmission rates. The following hypothesis (H) was explored:

H: Adult patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days, controlling for patient and hospital characteristics.

Definitions

For the purposes of this study, the following terms were defined:

Value-Based Purchasing (VBP)

Center for Medicare and Medicaid Services (CMS) defines value-based purchasing as part of a long-standing effort to link Medicare's payment system to a value-based system to improve health care quality, including the quality of care provided in the inpatient hospital setting. Value is a product or function of both quality and cost (AHRQ, 2002).

Pay for Performance Programs (P4P)

A payment incentive linked to the value (quality and efficiency) of care (Damberg et al., 2014). Now a widely adopted payment approach to reward or penalize hospitals with bonuses or payment reductions based on meeting pre-established targets or benchmarks for measures of quality, safety, and efficiency (Damberg et al., 2014; Werner et al., 2011).

30-day Readmission

CMS defines a hospital readmission as an admission to a hospital within 30 days of discharge from the same or another hospital.

Hours Per Patient Day (Proxy Measure of Nurse Staffing)

Endorsed by the National Quality Forum (n.d.) and the American Nurses Association (n.d.), hours per patient day (HPPD) is a metric used in determining budgeted full-time equivalents (FTE) and in comparing staffing across organizations (Kirby, 2015; Twigg et al., 2011). Hours per patient day is further delineated by the number of productive hours with direct patient care responsibilities per the number of patient days (RN, LPN/LVN, and aides) (Park et al., 2015).

Case Mix Index (CMI)

Case mix index is the average base diagnostic related-group (DRG)/Medicare-severity (MS) DRG weight for a hospital. CMI is used as the basis for CMS payment and reflects the diversity, clinical complexity, and the needs for resources in the population of all patients in the hospital (American Hospital Association, 2015).

Magnet®

Magnet® status is a recognition award given by the American Nurses' Credentialing Center (ANCC), an affiliate of the American Nurses Association, to hospitals that satisfy a set of criteria designed to measure the strength of quality patient care, nursing excellence and innovations in professional nursing practice.

Summary

Some hospitals facing financial uncertainty have sought to reduce nurse staffing as a way to increase profitability. Multiple studies have shown that adequate nurse staffing is a factor in promoting patient care quality and preventing adverse events. There is less evidence, however, about the relationship between nurse staffing and 30-day readmissions. In the presence of other reporting and incentive systems (e.g., P4P programs), assessment of nurse staffing levels and readmission outcomes to explore the relationships between the nursing workforce and patient care quality is important. The QHO model and structure-process-outcome (SPO) framework within the model describe and organize the complex reciprocal relationships among the hospital nurse staffing levels (*System)* and patient (*Client*) that affect readmission outcomes with the underlying influence of health policy. Findings from this study provide evidence to assist hospital and nursing leaders in developing a more complete view on the implications of inpatient nurse staffing levels on reduction of preventable readmissions.

CHAPTER 2

REVIEW OF LITERATURE

This chapter presents a review of the literature on hospital readmissions among patients diagnosed with specific CMS-targeted conditions (i.e., acute myocardial infarction, pneumonia, congestive heart failure, and elective total hip or knee arthroplasty) during the index admission and their association with nurse staffing and hospital characteristics. A summary of gaps in the extant literature also is identified.

Description of Search Methods

A systematic literature review was conducted using the Cumulative Index to Nursing and Allied Health (CINAHL®) and PubMed® databases to search for papers about effects of nurse staffing in improving organizational outcomes since enactment of the Affordable Care Act (ACA) in 2010. Primary search terms included nurse staffing, pay for performance, health care reform, health care workforce, readmissions, rehospitalization, and managing hospital costs. Each search was restricted to peer-reviewed articles from health services research in the English language and in acute care settings published between January 1, 2005 and May 31, 2017. In consideration to current literature and respect to pre-passage of the ACA, the literature review was limited to the previous 12 years. Seminal publications from the National Academy of Medicine, *Health Services Research*, and the *Journal of the American Medical Association* on access to care, health care quality, and nurse workload are included. The reference lists in key articles also were assessed during the review to identify other relevant papers for consideration. The literature review presented in this chapter encompasses four major relevant thematic topics of quality health outcomes: (a) the influence of health care reform policy to practice; (b) interwoven system concepts of hospital and nurse staffing characteristics on readmissions; (c) readmission reduction programs as an outcome measure of hospital quality performance; and (d) the role of patient demographic characteristics that may affect the hospital readmission performance.

Components of Quality Health Outcomes

Influence of Health Care Policy

The organization and delivery of health care services rapidly has changed under the 2010 Patient Protection and Affordable Care Act (ACA) (Gable, 2011; Oberlander, 2010; Rosenbaum, 2011; Starr, 2011). Traditional hospital-centric specialty care is shifting to an integrated care continuum model aimed at linking health care services for greater efficiency and effectiveness. Reimbursements that once rewarded providers for volume and higher level of care services has shifted to value-based contracting to align outcomes with financial incentives and public reporting of outcomes data. Value-based payment represents an evolution in payment models aiming to foster provider accountability for quality outcomes and costs.

The ACA is the most significant, yet controversial health policy legislation enacted since Medicare in 1965 (Rosenbaum, 2011; Starr, 2011). Key provisions are intended to provide near-universal coverage, lower health care costs and improve system efficiency, and eliminate denial of coverage due to pre-existing conditions (Rosenbaum, 2011; Starr, 2011). The ACA attempts to strengthen the health system to support key determinants of health by targeting some of the major impediments to accessing needed health care for millions of Americans (Gable, 2011). The ACA legislation primarily addresses health care financing and insurance but also contains strategic requisites, including value-based payment programs, intended to improve care in all acute care hospitals in the United States participating in Medicare (Gable, 2011; Ryan, Burgess, Pesko, Borden, & Dimick, 2014).

Value-based payment (VBP) programs signify a broad set of performance-based payment strategies linking financial incentives to performance on a set of defined measures such as heart failure 30-day readmissions. These VBP programs refer to a payment arrangement to providers rewarding them with bonuses or penalizing them in payment reductions based on meeting pre-established targets or benchmarks for measures of quality, safety, and efficiency often referred to as pay-for-performance (Damberg et al., 2014). Many of the provisions within the ACA legislation make changes to Medicare. Among these are provisions intended to reduce hospital readmissions (also referred to as rehospitalizations), which contribute to a significant proportion of total inpatient spending (Stone & Hoffman, 2010).

The fundamental change to VBP does not suggest that health care leaders have ever opposed improving outcomes but their central focus has been on growing volumes and maintaining margins (Porter & Lee, 2013). Hospitals participating in the Medicare program have always been required to meet Medicare's Conditions of Participation (CoP) (42 CFR 482.43). These health and safety standard requirements are considered the foundation for quality of care and safety of Medicare beneficiaries. Included among these CoP requirements are several that factor into hospital care delivery such as nursing services, patients' rights, a quality assurance program to evaluate hospital-wide patient care, utilization review that reviews services provided, as well as a discharge planning process that applies to all patients.

Prior to pay for performance programs within the ACA, hospitals were incentivized for each unit of service under the fee-for-service payment system that served to increase volume of care rather than to reduce it. Payment mechanisms directed at hospital processes to ensure effective discharge planning were not built into the payment system. Hospitals spending less on discharge planning received the same payment as hospitals that spent more. Post ACA implementation, hospitals could lose income by reducing readmissions (Kahn, 2015; Kavanagh et al., 2012; Kocker & Adashi, 2011; Stone & Hoffman, 2010). Even so, an efficient payment system alone cannot guarantee effective discharge planning (Stone & Hoffman, 2010; Weiss et al., 2007). The nurse's role in evaluation to preventing complications and effective discharge preparation during illness recovery may assist in identification of patient readiness, support systems, or barriers during the transition potentially to prevent avoidable readmissions (Jones et al., 2015; Weiss et al., 2007). Along with discharge planning, many of the VBP measures strongly are associated with nursing processes suggesting that investments in nursing hours to avoid penalties and the impact on reputation from public reporting may be an important strategy (Weiss, Yakusheva & Bobay, 2011).

Public and legislative debates to reform health care focusing on problems with access, costs, and quality of medical care date back decades (Gable, 2011; McLaughlin, 2005; Starr, 2011). Prior to the ACA, reports by the Congressional Budget Office estimated a six percent annual growth rate on Medicare spending that was expected to reach in excess of $230 billion in 2019 (Congressional Budget Office, 2010). Hospital services represented a significant portion of Medicare spending, as much as 29 percent in 2008 with continued growth predicted (Damberg et al., 2014; Jencks, Williams, & Coleman, 2009; Stone & Hoffman, 2010). Despite awareness that much of the hospital spending incurred by Medicare has been for a small percentage of high-cost Medicare beneficiaries, policymakers targeted hospitals in efforts to reduce overall spending costs and to improve the quality of care (Damberg et al., 2014; Lindenauer et al., 2007; Stone &

Hoffman, 2010). Up to the adoption of the ACA, various proposals to reforming health care policy had been the result of a series of compromises and incremental policies such as Medicare and Medicaid programs, replacing cost-based reimbursement with prospective payment for services in the 1980s to the 1996 Health Insurance Portability and Accountability Act (HIPAA) or the State Children's Health Insurance Plan (McLaughlin, 2005; Oberlander, 2011; Starr, 2011).

Multiple studies have described readmissions attributed to particular conditions, especially heart failure (Epstein, et al., 2011; Hodges, 2009; Joynt & Jha, 2011; Krumholtz, et al. 2013; Lindenauer et al., 2007; Retrum et al., 2013; Ross et al., 2008). Researchers have noted consistent findings on expenditures and prevalence of as many as one in four patients that are readmitted to the hospital within 30 days of discharge (Jennings et al. 2015; Joynt & Jha, 2011; Shah et al., 2015). In a seminal study on hospital readmissions, Anderson and Steinberg (1984) reached several conclusions. First, expenditures are concentrated on a small percentage of beneficiaries repeatedly admitted to the hospital. Second, there is a high frequency of patients discharged followed by readmissions within short periods of time. For example, over five percent of patients were readmitted within five days and more than 20 percent within 60 days. Last, costs are very high. Between 1974 and 1977 costs were $600 million annually for patients readmitted within five days and $2.5 billion annually for patients readmitted within 60 days (Anderson & Steinberg, 1984).

The landmark study on readmissions by Jencks et al. (2009) cited $12-17 billion annually and an overall 20 percent readmission rate. Prior to the 1982 prospective payment model, Medicare used a retrospective, cost-based reimbursement system to pay hospitals. Research from the RAND Corporation on the early effects of the prospective payment system also found that more Medicare patients were being discharged in an unstable condition than before the implementation of the inpatient prospective payment system policy in 1982 (Draper et al., 2006). Evidence over time suggests that the structure of payment policies influence the system practice patterns including hospital discharges.

Summary. With respect to hospital readmissions, the common strategic thread that runs through the ACA is incentivized coordination of care across transitions. As such, this policy approach considers that hospital readmissions (the often-avoidable byproduct of fragmented and ill-incentivized health care delivery) will respond to payment reform (Jencks et al., 2009; Kocher & Adashi, 2011; Lindenauer et al., 2007). Variation in readmission rates by hospital and geographic regions suggest that some hospitals are better at avoiding readmissions (Dharmarajan et al., 2013; Epstein et al., 2011; Jenck et al., 2009). A better understanding is needed about the relationship between nursing care, pay for performance programs, and outcomes including those relating to readmissions. These research opportunities have implications to the quality of care for patients, nursing practice, nursing education, and health policy.

Several policymakers and researchers acknowledge that not all readmissions are avoidable but note some could be prevented with improved hospital discharge processes (Jencks et al., 2009; McHugh et al., 2013; Stone & Hoffman, 2010; Weiss et al., 2007, Weiss, Yakusheva & Bobay, 2011). Researchers suspected that the 1982 prospective payment legislation that sought to control Medicare costs actually had a paradoxical effect, i.e., Medicare readmission rates and consequently costs increased (Anderson & Steinberg, 1984). Combining financial incentives and penalties, the ACA seeks to promote coordination across the continuum of care. Although the ACA legislation lacks reliable, system-wide cost controls, the legislation takes major steps toward slowing down the rate of growth in Medicare spending and promotes experiments in payment and delivery system reform (Oberlander, 2011). Through a variety of policies designed to move from fee-for-volume payments to fee-for-value payments, the ACA was intended to bend the cost curve (Oberlander, 2011).

Hospital Characteristics

A 2011 Dartmouth Atlas report found that more than half of discharged Medicare patients do not see a primary care clinician or specialist within two weeks of leaving the hospital; the report suggested the poor coordination of care between hospital and community clinicians was an indication of poor quality (Goodman, Fisher, & Chang, 2013). The report also noted higher readmission rates in regions where hospitals were used as the central point of care delivery. Further, the clarity of post-discharge care was scattered among hospital physicians and nurses, community physicians and nurses, and families. Problems and/or complications that could be prevented were missed, leading to avoidable emergency room visits and repeat hospitalizations (Goodman et al., 2013). Regardless of the illness levels within the community, improving care will require attention to overall systems of care while simultaneously improving hospital coordination of care and discharge planning (Goodman et al., 2013).

For hospitals to succeed at reducing readmissions, understanding the hospital characteristics is important, because even though hospitals are places where life-saving heroics are routine, hospitals also can be costly. Patients who do not need to be in the hospital should not be hospitalized. Getting the care patients need outside the hospital is imperative, and policy and payment initiatives should account for the interplay of the distribution of hospital resources and the role delivery and reimbursement systems play in hospital admissions and readmissions. (Brown et al., 2014; Goodman et al., 2011 & 2013).

There are many different reasons for variation in readmission rates across geographic regions and hospitals, including differences in patient health status, the quality of inpatient care, discharge planning and care coordination prior to discharge, and the availability and effectiveness of ambulatory services in the community (Brown et al., 2014; Goodman et al., 2011 & 2013). The 2011 Dartmouth Atlas Report illustrated the importance of the general tendency of health care systems to use the hospital as a primary site of care. The combination of those factors differed across communities and systems as each faced its own challenges in keeping patients well and out of the hospital (Brown et al., 2014; Goodman et al., 2011 & 2013).

Evidence suggests that other hospital non-clinical factors associated with regional quality and supply of health care also may influence readmission rates. Non-clinical factors include case mix index, bed supply or number of beds, and Magnet® status (Aiken et al, 2008; Aiken et al, 2011; Brown et al., 2014; Goodman, Fisher, & Chang, 2011 & 2013; Martsolf et al., 2014; Mendez et al., 2014).

Case Mix Index (CMI). Case mix index initially was designed for use in calculating hospital payment. CMI is usually derived from Diagnosis Related Groups (DRGs), which were developed in the 1960s by Yale University researchers to evaluate hospital performance using hospital discharges grouped by clinical and resource-utilization similarity (Ammar et al., 2013). CMI has been widely used as a proxy measure of disease severity and for the purpose of comparison across hospitals with different systems and regions (Mendez et al., 2014). For example, to examine regional variation in readmission rates, Epstein, Jha, and Orav (2011) used the CMI as a potential predictor of readmissions to explain hospital variations.

The CMI may be affected by the accuracy of physician documentation and experience of the coder who abstracts data from the medical record to assign payment codes (Mendez et al, 2014). Interventions by hospitals to improve documentation and coding may increase the hospital CMI despite providing similar care in patients with the same disease acuity, thus create limitations for this study. Regardless of the variation in hospital types, experience levels, treatments, and illness severity, CMI is commonly used to compare patient acuity mix across hospitals (Ammar et al., 2013; Mendez et al., 2014).

Size/Capacity (Number of beds). Significant variation in 30-day readmission rates exist among U.S. hospitals (Brown et al., 2014; Fisher et al., 2009). Hospital size as a measure of the number of beds for assessing capacity and to assist in describing the relationship to hospital readmissions is frequently cited in studies (Brown et al., 2014; Fisher et al., 2009; Martsolf et al., 2015; McHugh et al., 2013; McHugh & Ma, 2013). Brown et al. (2014) found a consistent effect that hospitals with greater capacity to admit patients for care had a higher 30-day readmission rate. The type of bed availability also may factor into hospital outcomes. Reduced ICU bed availability is associated with increased rates of ICU readmission and ward cardiac arrest (Town et al., 2014). The increased rates of ICU readmissions suggested that systemic factors (e.g., staffing workload and patient census) are associated with patient outcomes in the hospital population, and flexible critical care resources may be needed when demand is high (Town et al. 2014). For this study, the number of hospital beds as a measure of capacity was used to assist in describing the influence or impact of size on hospital readmission performance.

Geographic Region. The 2011 Dartmouth Atlas report noted geographic location of hospitals may be associated with a patient's risk for readmission; however, little research examines this direct association. The burden of readmissions falls unevenly on Medicare beneficiaries and is closely linked to their place of residence and the health system providing their care (Fisher et al., 2009; Goodman et al., 2011 & 2013). Urban hospitals may be more likely to be larger and be academic centers with high technology status; and therefore, more likely to attract sicker, more clinically complex patients (Brown et al., 2014; Lutfiyya et al., 2007; Toth et al., 2015). Rural hospitals, on the other hand, are more commonly smaller community hospitals and may have greater financial constraints (Brown et al., 2014; Lutfiyya et al., 2007; Toth et al., 2015).

Magnet® Status. A large and growing body of research suggests that nurse work environments are associated with patient outcomes and in mortality, hospital acquired infections, and readmissions (Aiken, Smith, & Lake, 1994; Aiken et al, 2008; Aiken et al, 2011; Ma, McHugh, & Aiken, 2015; McHugh & Ma, 2013). Magnet® designation often is used by researchers as a measure of the nurse practice environments. Beginning in 1994, the American Nurses Credentialing Center (ANCC) began awarding hospitals that met specified criteria demonstrating nursing excellence as Magnet®-designated hospitals (ANCC, 2014). Magnet®-designation has been considered a proxy measure for hospitals with exceptional nurse practice environments.

Summary. Hospitals are the largest and most comprehensive providers of acute health care services and increasingly are seen as one of the most important potential foci of accountability for care of numerous patient populations. Hospital environments, i.e., CMI, size/capacity, and Magnet® status, contribute to their capacity to reduce readmissions. The role of non-clinical factors identified for this study as influencing hospital readmissions assisted in describing the variability of these system characteristics across hospitals. Case mix index, number of beds, and Magnet® status have been shown to be important factors representative of hospital characteristics. These measures as hospital characteristics are frequently cited in nurse staffing and 30-day readmission research (Brown et al., 2014; Martsolf et al., 2014; McHugh et al., 2013)

Nurse Staffing

The following section describes hospital nurse staffing characteristics that were the primary predictors in this study. Nurse staffing in hospitals have been consistently shown to be associated with various patient outcomes, including readmissions (Cho et al., 2003; Kane et al, 2007; Kazanjian et al, 2005; Shekelle, 2013; Ma, McHugh, & Aiken, 2015; McHugh & Ma, 2013; Twigg et al., 2011; Unruh, 2008; Weiss et al., 2011). A review of research examining nurse staffing on readmissions is provided in Appendix C.

Nurse staffing is an integral element to patient care and delivered in a variety of settings such as the intensive care unit (ICU) and non-ICU. Nurses function in a variety of care roles and instrumental in achieving quality outcomes when considering few patient care processes are done without nursing involvement (Jones et al., 2015). The potential for harm is created when the flow of nursing care to patients is encumbered, patients may not receive all the services needed such as emotional support, education, care coordination, timeliness of care, discharge planning, or care planning (Jones et al., 2015). The sheer number of nurses and their central role in care quality are compelling reasons for measuring their contribution to hospital readmissions. A systematic review and meta-analysis of the association of Registered Nurse (RN) staffing levels and patient outcomes commissioned by the Agency for Health Care Research and Quality (AHRQ) concluded that there is substantial evidence that increased RN staffing is associated with better patient outcomes (Kane et al., 2007). An earlier report by the Academy of Medicine reached similar conclusions (Page, 2004). These comprehensive reviews helped draw attention on the business case for nursing, that is, that increased nurse staffing levels may cover the labor expense by preventing costly adverse patient outcomes.

Evidence that nurse staffing influences inpatient outcomes has been demonstrated repeatedly (Aiken et al., 2008; Clarke & Aiken, 2003; Clarke & Donaldson, 2008; Kavanagh, Cimiotti, Abusalem, & Coty, 2012; McHugh, et al., 2013; Van Bogaert et al., 2014). Landon (2006) reported patients hospitalized for heart attacks, congestive heart failure and pneumonia are more likely to receive high quality care in hospitals with higher registered nurse staffing ratios. A study of 232,342 surgical patients by Shekelle (2013) revealed that two percent died within 30 days of discharge. This study suggested that the differences in nurse-to-patient staffing ratios (1:4 vs. 1:8) may have been a factor in these patient deaths (Shekelle, 2013). Similarly, understaffing of RNs in hospital ICUs increased the risk of serious infections for patients (Hugonnet et al., 2007; West et al., 2014). Although optimal nurse-patient ratios for specific clinical situations have not been determined, adequate staffing and balanced workloads have been found to be central to positive patient and financial outcomes (Everhart et al., 2013; Martsolf et al., 2014; Unruh, 2008).

In 2004, California became the first state to mandate a minimum patient-to-nurse ratio requirement in acute care hospitals. Other states have explored legislative mandates. For example, in 2008 a similar bill of mandated ratios was passed in the Massachusetts House but not in its Senate. These legislation efforts were driven in reaction to managed care market penetration resulting from reports that hospital nurse staffing and skill mix were declining, and there were concerns for patient safety in hospitals (Mark et al., 2013). In response to fears that hospitals would react to the legislation by hiring lower-skilled labor, McHugh et al. (2011)

examined mandatory staffing requirements and reported the California mandate did not reduce the nurse workforce skill level. Although legislation has led to increases in nurse staffing, whether quality of care improved following this legislation is uncertain (Aiken et al., 2010; Mark et al., 2013; McHugh et al., 2011).

There is compelling evidence indicating a direct relationship between the number of patients that a nurse is assigned for care and whether the quality of those patient's care is high (Aiken et al., 2002, Kane et al, 2007; Needleman et al., 2002, Ma et al., 2015; McHugh et al., 2011; Unruh, 2008; Weiss et al., 2011). Along with the number of patients assigned, staffing mix that takes into account educational preparation, experience, and professional needs impacts the hospital environment as well as costs. Although Licensed Practice Nurses (LPNs) and aides are important members in the staffing mix, Needleman et al. (2002) determined that there was no relationship between patient outcomes and LPN or aide staffing. In contrast, a CMS coordinated care demonstration pilot intended to prevent unnecessary rehospitalization through use of dedicated nursing staff started enrolling patients in 2002. Lessons learned from one of the 15 randomized experimental pilots suggested that team-based approaches, coordinated inpatient care communication, and the use of care assistants with nurses may have a positive effect on reducing readmissions (Peikes et al., 2012).

Martsolf et al. (2014) examined the effect of nurse staffing on quality of care and inpatient care costs for a given discharge within the hospital. The study used two models to evaluate the level of nurse staffing (i.e., RN & LPN) and the total nursing staff (RN & LPN plus aides). They concluded that staff skill mix was associated with patient care cost reductions but not associated significantly with reductions in length of stay or AHRQ nursing-sensitive quality indicators. Although the Martsolf et al. (2014) study did not address the full value of inpatient nurse staffing on the health system (particularly RNs on patient care costs) or a hospital's overall financial performance, the findings were consistent with other research supporting the influence of nurse staffing on patient care. Despite the potential importance of the size and skill mix of nurse staffing on outcomes, more research is needed to fully understand this relationship.

Nurse staffing and readmissions. Growing evidence demonstrates a relationship between readmissions and nurse staffing particularly among Medicare patients with acute myocardial infarction, pneumonia, and congestive heart disease (Giuliano, Danesh, & Funk, 2016; McHugh et al., 2013; McHugh & Ma, 2013). There is a lack of evidence on the relationship of nurse staffing on COPD readmissions; whereas, there is limited but emerging evidence available on readmissions for elective total hip and knee replacements (Lasater & McHugh, 2016; Saucedo et al., 2014; Schairer et al., 2014; Schairer, Vail, & Bozic, 2014, Vorhies et al., 2011).

Five retrospective descriptive cohort studies on hip and knee arthroplasty readmissions were examined (Lasater & McHugh, 2016; Saucedo et al., 2014; Schairer et al., 2014; Schairer, Vail, & Bozic, 2014; Vorhies et al., 2011); however, only a single study by Lasater and McHugh (2016) examined the relationship of nurse staffing and total hip and knee arthroplasties. Of note, most hip and knee arthroplasty studies reviewed were found to examine these elective procedures in parallel. Lasater and McHugh (2016) concluded readmissions of patients discharged following major joint replacement are associated with nursing care. Furthermore, patients cared for in better hospital work environments, as measured from a nurse survey using the Practice Environment Scale of the Nursing Work Index (PES-NWI), had 12 percent lower odds of 30-day readmissions (Lasater & McHugh, 2016). The PES-NWI is a National Quality

Forum (NQF)-endorsed measure representative of work environment; among the domains measured is staffing and resource adequacy (Lake, 2002).

Efforts to reduce 30-day readmissions may be more effective through better discharge planning and care coordination (Brown et al., 2014; Stone & Hoffman, 2010). The quality of discharge teaching provided by nurses has been associated with patient perception of discharge readiness and readmission (Weiss et al., 2007 & 2011). Increasing both nursing hours and the proportion of nurses who are registered nurses would result in improved quality and potentially reduce readmissions (Kane et al., 2007; Martsolf et al., 2014; Needleman, 2008; Shekelle, 2013; Twigg et al., 2011; Weiss et al., 2007 & 2011). Weiss et al. (2011) found higher nurse staffing decreased the odds of readmission and affirmed a cost-benefit of investment in nursing care hours with the potential of costs avoided through averting post-discharge utilization. However, these hospitalization and financial benefits were to the patient and payer (Needleman, 2008). Under the inpatient prospective payment system, hospitals bear the increased labor costs but do not financially benefit given the reduced volume of hospital admissions (utilization).

Three studies within the last five years specific to examining the relationship of nurse staffing on 30-day readmissions were analyzed (Ma, McHugh, & Aiken, 2015; McHugh, Berez, & Small, 2013; McHugh & Ma, 2013). Two of these studies aimed to advance understanding on the role of the nurse work environment, nurse staffing, and nurse education on 30-day readmissions (Ma et al., 2015; McHugh & Ma, 2013). The third by McHugh and colleagues (2013) assessed the post-ACA regulatory environment and implications of the HRRP. Findings suggest hospitals that staff at appropriate levels for differing patient populations have lower readmission rates. Better nurse staffing may be considered as a system-level intervention to reduce readmissions and the associated HRRP penalties (Ma et al., 2015; McHugh et al., 2013; McHugh & Ma, 2013).

Hospitals could possibly reduce readmissions and the associated financial penalties by improving nurse staffing levels as a function of the practice environment (Ma et al., 2015, McHugh & Ma, 2013; McHugh et al., 2013). The nurse practice environment represents the hospital work setting characteristics that facilitate or constrain nursing practice (Lake, 2002). As mentioned earlier, the practice environment includes staffing and resources but also the relationships nurses have with other healthcare providers, including physicians, and their direct supervisors (Lake, 2002). Previous work has shown an association between the nurse work environments and readmissions (Lasater & McHugh, 2016; Ma et al., 2015; McHugh & Ma, 2013). The hospital practice environment may contribute to the multifactorial problem of readmissions; more research is needed in this area. Although skill mix is less understood, inpatient adverse events and quality of care are dependent on staffing (Kavanagh, Cimiotti, Abusalem, & Coty, 2012; Martsolf et al., 2014; McHugh et al., 2013; Weiss et al., 2011).

Many of the efforts to reduce hospital readmissions have focused on transitional and post-acute care, while there remains a weak understanding on the importance of nursing care delivered during a hospitalization (Coleman, Parry, Chalmers & Min, 2006; Jack et al., 2009) Cross-sectional studies on readmissions within 30 days of hospital discharge have shown an association with hospital nurse staffing, particularly among Medicare patients diagnosed with acute myocardial infarction, pneumonia, and congestive heart disease. Gaps exist on the relationship of hospital nurse staffing for patients readmitted with COPD and more studies are needed for elective total hip and knee arthroplasties. Building upon existing evidence, more research is important to understand the relationship of nurse staffing and readmissions among diagnoses of acute myocardial infarction, pneumonia, congestive heart failure, COPD, and elective total hip and knee arthroplasty for patients under age 65 with other payer coverage beyond Medicare. Moreover, research is needed to fully appreciate the association of workload, size, educational level, and skill mix of nurse staffing on readmissions.

Nurse staffing and hospital financial outcomes. Not all studies on nurse staffing costs have shown direct financial benefits to hospitals (Dall et al., 2009; Kane et al., 2007; Rothberg et al., 2005; Unruh, 2008). Direct financial benefits from investments in nursing may come from cost savings retained by the hospital from improved quality of services. However, a key point of distinction is a complex interaction among the business case, economic case, or social case benefits and the role in cost-off-sets and alignment between the hospital, patient, and payer (Landon et al., 2006; Needleman, 2008).

Cost off-sets in the health services research literature refer to spending in one resource category to achieve an equal or greater savings in another. Given the fragmented system of financing of health care in the U.S., cost off-sets often do not benefit the same entity making the initial investment, thus undermining the incentive (Aiken, 2008; Needleman, 2006 & 2008). For example, prior to the ACA HRRP, investments in nurse staffing have been shown to have a potential cost-benefit of avoided post-discharge utilization but these financial benefits were to the patient and payer (Needleman, 2008; Weiss et al., 2011).

A business case depends on whether the hospital retains the cost savings from a reduction in losses for a given program or population, or avoided costs (Needleman, 2008). Focusing attention on a business case for investments in nurse staffing, Kane et al. (2007) did a systematic review meta-analysis. Studies included in the meta-analysis had different designs (a weakness) but Kane and colleagues (2007) determined a causal likelihood between the prevention of costly adverse patient outcomes and nurse staffing. In contrast, results from Unruh (2008) were inconclusive after reviewing 117 studies published between 1980-2006 that met the criteria with regard to patient, nurse, and financial outcomes. Only 12 of the 117 were economic studies of nurse staffing and patient outcomes. An analogous systematic review by Twig and colleagues (2015) also were unable to conclusively determine the benefits of increased nurse staffing due to the small number of studies, the mixed results and the inability to compare results across studies.

Other factors associated with hospital nurse staffing decisions weigh in on value from the business perspective. Reduced nurse turnover from greater nurse retention produces substantial savings to hospitals when all the costs of replacing nurses are considered such as recruitment, on-boarding, overtime, and use of supplemental agency nurses (Aiken, Clarke, Sloane, Lake, & Cheney, 2008; Aiken, 2008). Undeniably hospitals face differing challenges and constraints in competing for patients, physicians, and payer network inclusion. Hospitals in markets with higher levels of competition must successfully recruit and retain nurses to achieve a competitive advantage over other hospitals in the market. Nurse staffing viewed from a market perspective may be an integral component for hospitals in competitive markets. Everhart et al. (2013) investigated the impact of nurse staffing on financial performance in competitive versus less competitive markets and determined cost-cutting through nurse staffing reductions in competitive markets negatively affect hospital financial results.

An economic case requires consideration of the cost of the services, distribution and financial accrual to the hospital (Needleman, 2008). A system-wide analysis of financial data by Dall et al. (2009) on the effect of nurse staffing on hospital and third-party payer cost concluded that there is an economic value to society but a negative economic effect on hospitals. Similar observations were made by Rothberg et al. (2005) reporting that increased staffing places a considerable financial burden on hospitals and the cost-effectiveness for the facility decreases as patient-to-nurse ratios decrease. Consistent with the other researchers, Needleman et al. (2006) reported if all U.S. hospitals staffed at the 75^{th} percentile, the net increase in hospital costs would be 1.5 percent. However, Rothberg et al. (2005), in making the social case that values the benefits to the patient and society without regard to the costs (Needleman, 2008), observed that investments in nursing for the cost of saving a life was in line with the costs of saving a life through commonly accepted medical care practices such as thrombolytic therapy for acute myocardial infarction and routine cervical cancer screening.

Notwithstanding of the nursing labor costs, review of research suggests that having adequate hospital staffing levels can reduce the length of stay, complications, and costs. Nurse staffing also may affect the hospital reputation (Everhart et al., 2013). A complex interrelationship exists among the business, economic, and social case perspectives and the outcomes associated with investments in nurse staffing. Understanding how the associated costs can be off-set by cost savings, or how the hospital can attract profitable patients and how it is paid is important. Current pay for performance programs such as the HRRP may create limited incentives for improving hospital nurse staffing levels through alignment of policy and a business case for nursing (Aiken, 2008; Needleman, 2008).

Summary. Acute care hospital nurses can promote optimal care that could reduce readmissions. Adequate nurse staffing is clearly associated with reductions in patient mortality and adverse patient outcomes. Given the impact of pay for performance programs on hospital reimbursements, more research is needed on the relationship between hospital nurse staffing and readmissions. Outcomes measures under VBP have a comprehensive effect on patient care, and in order to have low rates of quality deficits such as readmissions, a facility must identify optimum levels of nursing care to achieve the desired outcomes (Clark, et al., 2008, Kavanagh et al., 2012; Martsolf et al., 2014).

Research has shown that the odds of hospitals' achieving quality targets that would trigger payment premiums under pay for performance are increased as RN hours per patient day increase (Landon et al., 2006; Kane et al., 2007, Ma et al., 2015; McHugh et al., 2013). Despite the growing number of studies on readmission, few studies are specific to nurse staffing associated with readmissions for the CMS-targeted conditions. Hospital nurse staffing levels are linked to other patient outcomes (e.g., mortality, failure-to-rescue, and complications). This study aimed to narrow these gaps in health services research by examining the patterns of readmissions for CMS-targeted conditions and investigating the association with hospital nurse staffing.

Readmissions

History on the problem of hospital readmissions offers insight into the influence of health care policy as a determinant of care. Prior to the ACA, unless patient census was at full capacity, hospitals had no economic incentive to reduce readmissions under Medicare's diagnosis related group (DRG) prospective payment approach (Berenson, Paulus & Kalman, 2012; Needleman, 2008; Needleman et al., 2006). Under the ACA HRRP, hospitals are now accountable for excess readmissions. A review of the literature concerning readmissions for this study is provided in Appendix D.

Readmission Reduction Program (HRRP) is one of several programs in the ACA as a pay-for-performance initiative aimed to improve health care value through high quality outcomes at lower cost (James, 2012; Jha et al., 2009; Stone & Hoffman, 2010; Werner & Dudley, 2012). Hospitals with higher-than-expected rates of readmissions started incurring payment penalties in 2012 for worse than expected readmission rates. The HRRP has the greatest effects on hospital payments because penalties are applied to the base operating payment (Kocher & Adashi, 2011; Kahn et al., 2015). One recent study projected nearly 2,600 hospitals participating with CMS will be penalized for excess readmissions in fiscal year 2017 amounting to $528 million in Medicare reimbursements that is almost double from the fiscal year 2013 level (Thompson, Waters, Kaplan, Cao, & Bazzoli, 2017). To place these penalties in a quantitative perspective, an excess readmission for a hospital may represent as few as one to three patient readmissions per CMS condition over a three-year period. Hospital 30-day readmission rates also are publicly reported and accessible at the CMS website Hospital Compare (medicare.gov/hospitalcompare).

A hospital readmission is an admission to a hospital within a certain time frame, following an original admission and discharge. A readmission can occur at either the same hospital or a different hospital and can involve planned or unplanned surgical or medical treatments. The time frame defining a readmission is unclear, but policy analysts often refer to hospital readmissions within seven, 15, or 30 days (Jencks, 2009; Stone & Hoffman, 2010). In some cases, the time frame is 60 or 90 days or even one year following discharge (MedPAC, 2007). CMS has defined the time frame for readmissions to be within 30 days. For purposes of legislative options, longer time frames could provide Medicare the opportunity to save more money but create more controversy (Stone & Hoffman, 2010)

Identifying whether a readmission is preventable is unclear. There is no consensus on how to distinguish among the readmissions that might have been avoided (Stone & Hoffman, 2010). Payers, providers, hospital, and health systems have defined potentially preventable readmissions differently. For example, some have tried to define the potentially preventable readmissions for the purpose of implementing strategies to reduce hospital readmission rates; others count only readmissions that are billed under the same Medicare payment diagnostic category (MedPAC, 2007).

The initial targeted conditions under the HRRP "payment penalty" strategy began among Medicare patients with congestive heart failure, acute myocardial infarction, and pneumonia but have now expanded to cover chronic obstructive pulmonary disease, and elective total hip and knee arthroplasty (Axon & Williams, 2011; Damberg et al., 2014; Goodman et al., 2013; Kahn et al., 2015). COPD is a common, debilitating disease and leading cause of readmission (MEDPAC, 2007). A greater number of primary joint replacements given the aging population may have an underlying role in adding this as a CMS measure (Kurtz et al., 2005). There are nearly one million elective total hip or knee arthroplasty procedures in the U.S. (American Academy of Orthopedic Surgeons, n.d.). Some evidence showing hospital postsurgical complication rates following elective hip and knee arthroplasty range between 1.8 and 8.9 percent suggesting there is room for improvement (Grosso et al., 2012). Beginning with CMS, the subject of readmissions has drawn increasing scrutiny from other third-party payers. Geisinger and United Healthcare are closely monitoring readmission rates for these purpose of implementing strategies to improve hospital quality outcomes of care and withholding payment for poor performance (Stone & Hoffman, 2010).

Jencks et al. (2009) and a Medicare Payment Advisory Commission (MedPAC) (2007) reported nearly 20 percent of Medicare fee-for service beneficiaries who had been discharged from a hospital were readmitted within 30 days. Further, almost 10 percent were readmitted within seven days of discharge while more than half within one year of discharge (Jencks, 2009;

MedPAC, 2007). Nationally, one in four Medicare patients experiences an unplanned readmission within 30-days of discharge from the index admission resulting in an estimated annual cost of $12-17 billion (Jencks et al., 2009). In compelling evidence over time on the problem, Jencks, et al. (2009) had similar results to a seminal study by Anderson and Steinberg (1984) that found a greater than 30 percent readmission rate at 60 days and each representative of a disproportionate but high-cost group of patients.

Readmissions as an indicator of health care quality. A readmission matters to patients (Goodman et al., 2013; Lindenauer et al., 2011). Although patients' perceptions of their hospital care are not well understood, findings in a cross-sectional 36-item survey administered to 1,084 readmitted inpatients to evaluate the patient perceptions of readmissions most frequently attributed lack of discharge preparedness of the index hospitalization and socio-economic status (Kangovi et al, 2012).

Boulding et al. (2011) found positive patient experiences with lower 30-day hospital readmission rates and suggested patient-centered information may have a central role in evaluating hospital performance. A considerable proportion of Medicare patients had unplanned hospital readmissions within 30 days of discharge (Jencks et al., 2009; Boulding et al., 2011; Goodman et al., 2013; Weiss et al., 2011). A Medicare patient's perception of the hospital's discharge process was found to be significantly associated with reduction in hospital 30-day readmission rates (Boulding et al., 2011). Furthermore, 30-day readmission rates were associated with improvement of patient perception of care (Boulding et al., 2011).

Hospitals are expected to take central responsibility in reducing readmissions under provisions set forth in the ACA (Axon & Williams, 2011; Kahn et al., 2015). The risk adjustment for payment on the HRRP measure has been a source of criticism since it does not adjust for sociodemographic factors long considered a contributing factor of readmissions (McHugh et al., 2013; Kahn et al., 2015). While risk-adjusting for sociodemographic factors can mask poor quality of care in low-income areas, there is some concern that the HRRP penalties for hospitals serving vulnerable populations could exacerbate the problem and reduce access to high-quality care for low-income patients (Kahn et al., 2015). There is emerging evidence suggesting that the HRRP has led to reductions in readmissions for the targeted conditions and that the effects may have spilled over to non-targeted conditions and privately-insured populations (Zuckerman, Sheingold, Orav, Ruhter, & Epstein, 2016).

Hospital readmission reduction program targeted conditions. Studies on readmissions are generally limited to descriptive correlational designs using secondary data, typically from CMS Medicare claims. Administrative data are useful because clinical indicators are available (e.g., admission and discharge dates, diagnoses, procedures), demographic data are included, and using the data sets are cost-effective. However, there are broad limitations to consider. Conditions must be diagnosed by physicians and coded appropriately by hospital coders. Some diseases are known to be under-diagnosed or under-documented. And, while the record reflects the care received, it does not provide information on the care needed. Claims data are derived for reimbursement information, or pieces of information required to determine payment (ResDAC, 2012). The HRRP targeted conditions are detailed below:

Pneumonia. Pneumonia is the second most common reason that patients are readmitted within 30 days. Pneumonia readmissions vary based on pneumonia type, across hospitals, and regions especially at low performing institutions and areas. (Lindenauer et al., 2011; Shorr et al., 2013). Efforts to understand the epidemiology of readmission following a hospitalization for pneumonia have derived from analyses of CMS hospital claims datasets mainly covering those 65 years of age and older (Chen et al., 2010; Dharmarajan, et al., 2013; Epstein, Jha, & Orav, 2011; Flanagan & Stamp, 2016; Krumholtz et al., 2013; Lindenauer et al., 2011). Approximately 20-25 percent of these patients are readmitted within 30 days.

Studies examined pneumonia with other conditions such as heart failure and had a variety of objectives ranging from mortality to performance patterns and assessing variation of hospital regional rates (Chen et al., 2010; Dharmarajan et al., 2013; Epstein et al., 2011; Krumholtz et al., 2013; McHugh & Ma, 2013). Findings notable for pneumonia readmissions higher rates included coexisting conditions and hospitals with fewer resources (Chen et al., 2010; Dharmarajan et al., 2013; Epstein et al., 2011; Krumholtz et al., 2013; McHugh & Ma, 2013).

Shorr et al. (2013) sought to understand the impact of healthcare-associated pneumonia and community-acquired pneumonia. This retrospective cohort study consisted of 977 adult patients with non-nosocomial pneumonia admitted among nine different hospitals (January through December 2010). Readmission rates were consistent with other studies and there were no differences in demographics between those readmitted and not readmitted; nor in severity of illness. More readmitted patients had received broad-spectrum antibiotic therapy prior to the index hospitalization (61.7% vs 38.9%, $p<.001$). However, the prevalence of bacteremia did not differ based on eventual readmission status (Shorr et al., 2013).

Flanagan and Stamp (2016) examined hospital characteristics, patient experience of care, demographic data, and hospital-acquired conditions associated with readmissions. Results showed that pneumonia excess readmission ratios are associated with nurse staffing ratios, nurse response to patient needs, and nurse communication with patients (Flanagan & Stamp, 2016).

McHugh and Ma (2013) also found that nursing care influenced pneumonia readmission. Patients cared for in hospitals with a good work environment had 10 percent lower odds for pneumonia readmissions (McHugh & Ma, 2013).

Congestive Heart Failure. The most common cause of both hospitalizations and readmissions in the Medicare program is congestive heart failure (Giuliano et al., 2016; Joynt & Jha, 2011). Despite the attention to congestive heart failure readmissions, little is known about actual causes. Many studies used cardiac registries and administrative claims data (Dharmarajan et al., 2013; Epstein et al., 2011; Hodges, 2009; Jha et al., 2009; Kahn et al., 2015; McHugh et al., 2013; Giuliano et al., 2016); whereas, other studies relied on clinician impressions from chart review (van Walraven et al., 2011). A systematic review by Ross et al. (2008) sought to describe statistical models designed to compare hospital rates of congestive heart failure readmissions and to assess patient risks for readmission. After reviewing studies published between 1950 and 2007, 117 articles met the diverse criteria for inclusion. Results did not identify any statistical model to compare hospital readmission rates; although there were prediction models, they were inconsistent and had disparate approaches (Ross et al., 2008).

A prospective cohort analysis found no association between the proportion of patients who had an urgent readmission and the proportion of patients who had an avoidable readmission (van Walraven et al., 2011). Several studies had assorted objectives in relation to hospital congestive heart failure readmission that included: variation in rates, mortality, patterns of performance, and work environment (Dharmarajan et al., 2013; Epstein et al., 2011; Hodges, 2009, Kahn et al., 2015; McHugh et al., 2013; Giuliano et al., 2016). Heart failure readmissions were weakly associated with mortality (Krumholz et al., 2013). Staffing levels and good work environments were associated with seven percent lower odds for readmission (Giuliano et al., 2016; McHugh & Ma, 2013). When extending on previous findings on predictors of hospital performance, higher performing hospitals had longer median times to readmission than lower performing hospitals (Dharmarajan et al., 2016).

Relatively few studies have integrated the patient's perspective. Through semi-structured qualitative interviews with patients, Retrum et al. (2012) found factors associated with heart failure readmissions focused around five themes: distressing symptoms, unavoidable progression of illness, influence of psychosocial factors, good but imperfect self-care adherence, and health system failures (Retrum et al., 2012). Horwitz et al. (2013) evaluated patient understanding of discharge and follow-up through patient interviews and compared responses to the patient's medical record. The study found that patient perceptions and written documentation did not adequately reflect patient understanding of discharge care (Horwitz et al., 2013). The findings were consistent with the Retrum et al. (2012) study.

To evaluate hospital financial resources that may impact heart failure readmission rates, Joynt and Jha (2011) used the Medicare Provider Analysis Review (MedPAR) from 2006 and 2007 to examine patient hospitalizations in small and public hospitals. Hospitals were selected given the similar characteristics of fewer resources to invest in cardiac services, low levels of nurse staffing, as well as patient education and discharge planning that may influence a hospital's likelihood of performing in the worst quartile of readmissions nationally (Joynt & Jha, 2011). Limited hospital financial resources influenced performance and could result in disproportionate readmission rates (Joynt & Jha, 2011).

Acute Myocardial Infarction (AMI). Like pneumonia and heart failure, AMI was selected for the HRRP because CMS identified these conditions as high volume or high expenditure (Axon & Williams, 2011; Krumholtz et al., 2011, 2013). Randomized trials have shown that medical and interventional therapies improved outcomes for AMI patients (Mehta et al., 2005; Baigent et al. 2005). Stukel et al. (2010) found that AMI readmissions were particularly sensitive to care processes and the need for strategies that promote better inpatient management of these patients. A limitation from this longitudinal cohort study was that only patients likely to have similar baseline severity across hospitals and admitted to larger hospitals were included.

Other retrospective descriptive studies had varying but similar purposes mostly using administrative claims data. Krumholtz et al. (2013) found mortality rates and AMI readmission rates were not associated; using a bootstrap algorithm to determine hospital performance. Dharmarajan et al. (2013) noted that there were no notable differences in median time to readmission among high, average, and low performing hospitals. High and low performing hospitals had a 95 percent or greater probability of having an interval estimate less than or greater than the national average over the three-year period of study. However, the study was restricted to Medicare FFS beneficiaries with more than 25 index admissions; therefore, the findings might not be generalized to a younger population of patients (Dharmarajan et al., 2013). Brown et al. (2014) focused on the association between hospital patterns of medical care quality such as discharge planning, capacity, supply of primary care physicians and cardiologists. The study found that AMI readmissions rates were associated with hospital-level measures of capacity and intensity, similar to findings from Fisher et al. (2009). McHugh and Ma (2013) reported that patients cared for in hospitals with a good work environment (based on the PES-NEI nurse survey) had six percent lower odds of readmissions.

Chronic Obstructive Pulmonary Disease (COPD). The 30-day readmission rate for patients with COPD was 20.5 percent in 2008 (Jennings et al. 2015). Hospital readmissions for COPD have been identified as the fourth costliest, potentially preventable readmission (MedPAC, 2007). Studies have found a variety of risk factors associated with 30-day readmissions for COPD (Baker, Zou, & Su, 2013; Glaser & El-Haddad, 2015; Hansen et al., 2011; Prieto-Centurion et al., 2010; Shah et al., 2015; Yu et al., 2015). To date, identifying successful interventions to prevent these readmissions has been elusive (Hansen et al., 2011; Prieto-Centurion et al., 2010; Shah et al., 2015).

Researchers conducting a single-center randomized controlled trial found that a pre-discharge bundle with screening for gastroesophageal reflux disease, depression, anxiety, smoking cessation education, inhaler education, and a 48-hour post-discharge telephone call was not sufficient to reduce acute COPD readmissions (Jennings et al., 2015). Of note, staff nurses completed the patient education techniques on the proper use of inhalers as part of the routine discharge process. The primary team was inpatient pulmonology, other confounding factors of the hospital model for nurse staffing are not included. The simple tool designed to identify and target acute exacerbations of COPD risk factors was ineffective at reducing 30- or 90-day readmissions (Jennings et al., 2015). Patient compliance with the team recommendations in this study was not examined. Actions and/or interventions acted upon from the identified patient risk factors by the primary care team were varied and based upon the subjective judgement of the team thus drawing conclusions on the effectiveness of the pre-discharge bundle problematic.

Elective Total Hip and Knee Arthroplasty. Preventable readmissions following elective total hip arthroplasty (THA) and total knee arthroplasty (TKA) have become the first surgical procedures to be targeted for financial penalty for hospitals with worse than expected readmission rates (PPACA, 2010). THA and TKA are common surgical treatments for arthritis, caused in part by normal wear and tear on joints related to aging. Joint deterioration also can be exacerbated by undue stress on joints due to obesity. Given an aging baby boomer generation and the rising incidence of obesity, the numbers of THA and TKA procedures have increased over time (Kurtz et al., 2005).

Kurtz et al. (2005) quantified the joint revision burden changes over time (i.e., procedural volume and economic burden) in the United States. The research examined whether the historical increase in the annual number of both primary and revision arthroplasties could be explained on the basis of an increase in selected age or gender-based segments of the U.S. population (Kurtz et al., 2005). Primary THA revisions increased by 3.7 per 100,000 over a decade reflecting an approximately 50 percent increase in volume. Primary TKA revisions increased by 5.4 per 100,000 during the same decade, reflecting tripled volume. The mean revision burden of THA was more than twice than TKA; however, these differences did not show a substantial change over the decade (Kurtz et al., 2005).

The authors did not elaborate on why the THA revision burden is higher than the TKA but external factors related to the device manufacturer and/or patient age and sex might to have a role. The effect of age and gender on reimbursements also varied by procedure type. Nearly two-thirds of the THA and TKA procedures performed annually in the U.S. are paid for by Medicare (AAOS, 2014; Ong et al., 2006).

THA and TKA surgeries account for Medicare's largest procedural cost (Bozic et al., 2008; Saucedo et al., 2014). Despite the high cost, readmissions following THA and TKA surgeries are relatively uncommon when compared with readmission rates for medical conditions, such as congestive heart failure (1 in 4), acute myocardial infarction (1 in 5) and pneumonia (1 in 6) (Krumholz et al., 2009; McHugh & Ma, 2013; Saucedo et al., 2014). The 30-day readmission rate following THA and TKA is approximately five percent in the Medicare population (Suter et al., 2014).

Primary reasons for readmission of THA patients are usually medical issues rather than surgical issues. Common medical reasons for readmission after THA included pneumonia, dehydration and renal dysfunction, deteriorating mobility, congestive heart failure, cardiac dysrhythmias, osteoarthritis, acute myocardial infarction, and diabetes (Khan et al., 2012; Vorhies et al., 2011). Common medical causes included cardiac and pulmonary problems (Schairer et al., 2014; Vorhies et al., 2011).

Common surgical reasons for readmission in THA included dislocation of the prosthesis, surgical site infection, wound disruption, and postoperative hematoma (Pugely et al., 2013; Saucedo, 2014; Schairer et al., 2014). Reasons for readmission following TKA were related to surgical issues, such as surgical site infection, cellulitis, and arthrofibrosis (Schairer, Vail, & Bozic, 2014). Surgical site infections were the most common reason for unplanned readmission following THA and TKA (Merkow et al., 2015).

Most studies of readmissions for elective total hip and knee arthroplasties were retrospective descriptive cohort using administrative or registry data. Several of the studies were conducted at a single center (Pugely et al., 2013; Saucedo, 2014; Schairer et al., 2014). Overall, readmissions for patients with major joint replacement were relatively uncommon. Consistent with the multifactorial reasons for readmissions of medical conditions, there was no consensus regarding the principal reasons why patients were readmitted following either a THA or TKA.

Summary. Programs have been developed to reduce hospital readmissions. Some programs have achieved success in reducing readmission, such as the advanced practice nurse directed transitional care program and the reengineered discharge program (Coleman, Parry, Chalmers, & Min, 2006; Jack et al., 2009; Peikes, 2012). Nurses are key players in implementing these interventions suggesting a direct effect of nursing care on hospital readmissions.

Some evidence links inpatient nurse staffing to condition specific readmissions; however, no studies have addressed the relationship between nursing staffing hospital readmissions on each of the HRRP targeted conditions. Furthermore, despite the programs that have been developed to reduce hospital readmissions, a review of the literature has shown the causes to be multifactorial, and that many of these programs focus only on discharge planning or post-discharge care, and not all of the available interventions to reduce readmissions are effective (Hanson et al., 2011; Horwitz et al., 2013; Peikes, Chen, Schore & Brown, 2009). As a result, there exists continued interest of the health care professionals, hospital administrators, and policymakers in further searching for new ways to avoid unplanned hospital readmissions.

Patient Characteristics

Current efforts to reform and restructure the U.S. health care system create new demands for health services research. Health services research brings together the social science perspectives to investigate how social factors, health policy, organizational structures, and behaviors affect access, quality and costs of care, and outcomes. Patient characteristics are commonly described in the literature in terms of their sociodemographic characteristics (Polit & Beck, 2008).

Potential factors associated with being readmitted after an initial hospitalization can be grouped into five broad categories: patient characteristics, social circumstances, health system, clinical care or process, and health outcomes (Kilkenny, et al., 2013). Little is known about which patient characteristics result in higher probability of a readmission (Stone & Hoffman, 2010). However, there are indications the problem is multi-factorial and that more commonly, patients with chronic illness are readmitted.

Patient demographic characteristics and comorbid conditions are important factors to be considered in health outcomes research because they affect patient outcomes. These patient characteristics are considered non-modifiable because they are not changed easily (Polit & Beck, 2008). Patient basic demographic characteristics used in readmission studies usually include age, sex, and race (Lasater & McHugh, 2016; Ma et al., 2015; Martsolf et al., 2014; Stone & Hoffman, 2010; Weiss et al., 2010; Jack et al., 2009)

Since the introduction of the prospective payment system in 1982, U.S. hospitals have been incentivized financially to reduce inpatient length of stay, and average length of stay has shortened dramatically (Southern & Arnsten, 2015). To evaluate the sensitivity of treatment effects length of stay is used for control of patient characteristics. Patient length of stay is an important performance indicator for efficient care management practices of hospitalized patients (Needleman et al., 2006). Patient severity of illness is generally associated with length of time required for maximum recovery.

Summary

Review of the research literature provide evidence of the links between structural elements (i.e., hospital characteristics and nurse staffing) and readmission outcomes as well as the overarching influence of health care policy. Research findings support the primary links in the Quality Health Outcomes Model (Mitchell, et al., 1998) that incorporates the traditional structure-process-outcomes (SPO) framework, and also recognizes the dynamic interrelationships among clients, system, and interventions, as related to the key outcome of readmission.

Many of the studies were descriptive or correlational using administrative data sets. The correlational designed studies, critiqued from the previous research (and as planned in this study), provide a descriptive statistic, regression design however, still does not measure cause and effect (Polit & Beck, 2008). Nonetheless, Polit and Beck (2008) have suggested that the limited, or lack of, available research (in this case, measuring or predicting for a relationship of nurse staffing on 30-day readmission of CMS-targeted conditions) supports the use of correlational research as an appropriate design strategy. Researchers have suggested longitudinal designs to move the body of knowledge toward determination of causation, or causal comparative determination (Aiken et al., 2002).

Currently there is limited research literature relating the system elements of nurse staffing and the outcome of acute care hospital 30-day readmissions on the CMS-targeted conditions. Greater understanding compels the need for this study, using a descriptive correlational design. Most research has used Medicare administrative claims data that limits generalization to those under age 65. This study used hospital administrative claims data for adults only but extends below the Medicare claims data that are limited to age 65 and above. After controlling for the hospital-level variables of case mix index, number of beds (size), geographic region (Mid-Atlantic, Mid-Continent, Midwestern, New England, Southeastern, and Western), and Magnet® status; and patient characteristics variables of sex, race, age, and length of stay, this study examined the relationship of acute care hospital nurse staffing levels affect readmissions within 30-days of discharge from the index hospital.

In Chapter 2, the research literature has been summarized. Understanding the relationship between nurse staffing on readmissions within 30-days for selected CMS-targeted conditions is needed, especially given the presence of pay-for-performance. Chapter 3 discusses the methodology (design, data source and study sample, measures, and statistical analysis as well as limitations, validity, ethical considerations, etc.) required to determine if indeed a relationship existed between the variables of interest.

CHAPTER 3

METHODOLOGY

Introduction

This chapter addresses the methodological aspects of the study to understand the effects of hospital nurse staffing on the likelihood of 30-day readmission for adults with CMS-targeted conditions, i.e., acute myocardial infarction, pneumonia, heart failure, chronic obstructive pulmonary disease, and elective total hip and knee arthroplasty. Understanding this relationship will: (a) strengthen knowledge of the variation and time between discharge and readmission among the CMS-targeted conditions on patient readmissions with 30 days of discharge, (b) clarify hospital characteristics and patient characteristics that are associated with readmissions within 30 days of discharge, and (c) provide evidence of the impact of nurse staffing levels and staffing mix on patient readmission within 30 days of discharge among CMS-targeted conditions.

In this chapter, the research design and appropriateness, study sample, and plan for measuring variables of interest are described. Data analysis for research questions, as well as the methodological limitations and assumptions, are discussed. Last, the concern for and attention to issues related to data integrity and human subjects are addressed.

Research Design

This study used a descriptive correlational design to perform a secondary analysis of existing data. The study design controlled for the hospital-level variables of case mix index, number of beds (hospital size), geographic region, and Magnet® status; and patient characteristics variables of sex, race/ethnicity, age, and length of index hospital stay. Polit and Beck (2008) noted that correlational study design is appropriate when examining the extent to which particular characteristics or variables are related to, or descriptive of, a dependent variable outcome. Further, correlational design aligned the study of relationships and descriptive exploration to systems theoretical tenets (Polit & Beck, 2008).

Given the limited knowledge in research, a descriptive correlational design was the best fit for the research problem. Noting, causation cannot be inferred from correlational designs (Polit & Beck, 2008).

Data Source

A better understanding is needed about the relationship between nursing care, pay for performance programs and outcomes including those relating to readmissions. There is limited knowledge from the literature regarding the descriptive relationship of hospital nurse staffing to readmissions within 30 days of discharge. Building upon existing knowledge of nurse staffing is needed to have more understanding on the influence of nurse staffing on readmissions within 30 days for the CMS-targeted conditions, i.e., AMI, pneumonia, heart failure, COPD, and elective total hip and knee arthroplasty that compels the need for and feasibility of the descriptive correlational design. In addition, most existing studies have used Medicare administrative claims data that limits generalization to those age 65 and above. This study used hospital administrative claims data for adults only and included age 18 and over for all payers. The publicly reported hospital outcomes also have drawn attention from commercial payers and employers interested in finding population health strategies to control health care costs and leverage network participation.

The data set was obtained from Vizient (formerly known as University Health System Consortium [UHC]), a voluntary alliance involving over 5,200 nonprofit academic medical centers and integrated hospital systems across the U.S. (vizientinc.com). Members are geographically diverse and represent a range of independent, community-based health care organizations to large, integrated systems and academic medical centers across the U.S. Vizient was formed in 2015 in a merger of VHA, Inc. (national not-for-profit health care network) and UHC, an alliance of leading U.S. not-for-profit academic medical centers.

Vizient membership (vizientinc.com) gives hospital organizations access to learning networks of clinical, operational, and supply chain performance resources impacting health care that include nurse staffing, quality outcomes and patient safety data. Vizient data and analytics are available for strategic research, advocacy, and benchmarking for affiliated hospitals. A hospital organization's cost of membership is based upon the number of Vizient program offerings selected, although all members have access to the Vizient Research Institute (vizientinc.com). Among the member programs offered are networks and analytics for senior leadership, supply chain, pharmaceutical, risk management, quality resources and performance improvement collaboratives, and research. These programs support data-driven, collaborative efforts towards cost-effective outcomes, performance improvement, quality, and research. Member hospitals transmit their administrative data files monthly to Vizient via secure networks.

The calendar year 2016 was the most recent year with complete data available for this study. The data included hospital-level measures and patient-level discharge abstracts. The patient-level data were used to calculate readmissions within 30 days of discharge from the index hospitalization where both the index discharge and readmission occur within 2016. For the analyses, all datasets were merged at the patient-level. Table 3.1 shows how the Vizient

Operational Data Base and Clinical Data Base, from which the datasets for this study were obtained, are linked together by the hospital identifier (Table 3.1). Operational definitions of the study variables are provided in Tables 3.3, 3.4, and 3.5.

Table 3.1

Data Sources and Linkage from Vizient.

OPERATIONAL DATA BASE	**CLINICAL DATA BASE**
Contains *Hospital Identifier*	Contains *Hospital Identifie*r Patient Identifier
Nurse Staffing Productive Hours Per Patient Day (NHPPD) direct care providers	30-Day Readmissions Pneumonia Heart Failure Acute Myocardial Infarction Chronic Obstructive Pulmonary Disease Elective Total Hip Arthroplasty & Knee Arthroplasty
Hospital Characteristics Magnet® Status	Hospital Characteristics Case Mix Index Number of Beds (Size/Capacity) Geographic Region (Mid-Atlantic, Mid-Continent, Midwestern, New England, Southeastern & Western)
	Patient Characteristics Sex Race Age Length of Stay

Study Sample

Nurse staffing data were submitted to the Vizient Operational Data Base by approximately 120 member hospital organizations. The Operational Data Base contains information on nursing care unit characteristics such as nurse staffing, and Magnet® status. The Clinical Data Base contains information from 300 affiliated hospitals on hospital characteristics such as case mix index, and size. This data base also contains information on patient admissions and discharges of hospital-coded discharge abstracts using *ICN-9-CM* codes used to categorize quality outcome data by hospital. Approximately 120 hospitals submit at least some data to the Operational Data Base but may not submit data to the Clinical Data Base and 300 hospitals submit data to the Clinical Data Base but may not submit data to the Operational Data Base. The data bases were merged using a hospital identifier, 30 hospitals submitting data to both the Operational Data Base and the Clinical Data Base are included in this study.

Vizient removed all hospital and patient identifiers before transmitting the data. Operational and Clinical data sets were linked by hospital identifier. Nursing units for adult patients were selected, excluding those for pediatric, obstetric, psychiatric patient care, and rehabilitation to concentrate on adults and cohort groups receiving care in critical care, medical and/or surgical hospital units. Readmissions for CMS-targeted conditions (i.e., acute myocardial infarction, pneumonia, heart failure, chronic obstructive pulmonary disease, elective total hip and knee arthroplasty) were calculated using hospital index admission and discharge data from the patient discharge records of adult inpatients aged 18 years and older, who are not obstetric, rehabilitation, or psychiatric patients.

Measures

Nurse staffing characteristics (independent variable). Past studies support the use of productive hours by nursing staff in measuring nurse staffing (Park et al., 2015; Spetz et al., 2008; Twigg et al., 2011). Nurse staffing levels differ significantly across unit types; for example, ICUs have much higher staffing than non-ICUs. For the patient population of interest, nurse staffing was evaluated using direct-care nursing hours per patient day (NHPPD) at the hospital-level. Although the Vizient data set provides quarterly nurse staffing data, a past study with the Vizient data found that quarterly nurse staffing levels did not vary across quarters and could be considered to be independent based on their endogeneity test (Blegen et al., 2011). Therefore, nurse staffing measures were aggregated to the annual hospital-level for this study.

Definition of productive hours per patient day (NHPPD). Hours as productive represent direct-care providers that carry out nursing activities with patients and/or families directly and do not include hours spent in activities other than patient care, such as continuing education, sick leave, or vacation (Park et al., 2015). For this study, nurse staffing was defined using productive hours per patient day at the hospital-level (total of ICU and non-ICU inpatient units) for nursing staff. Nurse staffing was operationally defined as NHPPD, calculated by the number of hours divided by the number of patient days.

30-day readmission outcomes (dependent variable). An index discharge that is followed by hospitalization within 30 days establishes a readmission, which allows the readmission to be tracked as a binary outcome (1, 0) of an index hospitalization. Admissions for patients who died during an index hospitalization (no opportunity for readmission) were excluded for the calculation of readmission rates. The CMS-targeted conditions of acute myocardial infarction, pneumonia, heart failure, chronic obstructive pulmonary disease, elective total hip arthroplasty, and elective total knee arthroplasty have strata defined by diagnosis codes with *International Classification of Disease, Ninth Revision (ICD-9-CM).* Similar diagnosis codes are groups into each condition stratum. For example, pneumonia is 480, acute myocardial infarction is 410 (See Appendices A and B).

Definition of index admission and readmissions. An index admission was defined as any inpatient hospitalization that is eligible to have subsequent admission to the same hospital. A readmission was defined as an inpatient hospitalization, regardless of the cause, within 30 days of the previous discharge from the same hospital. Under this definition, a hospitalization could have been an index hospitalization, readmission, or both, depending on its time interval to the previous hospitalization and the subsequent one. The readmissions are illustrated using fictional patient scenarios in Table 3.2.

Table 3.2

Fictional Patient Examples for Defining Index Admission and Readmission.

	First Hospitalization, Admit Date and Discharge Date	**Second Hospitalization, Admit Date and Discharge Date**	**Third Hospitalization, Admit Date and Discharge Date**	**Index Admission**	**Readmission**	**Readmission Rate**
Patient 1	3/30 and 4/3			First	None	
Patient 2	1/15 and 1/19	3/20 and 3/28		First and second	None	3/8 = 37.5%
Patient 3	2/10 and 2/15	3/8 and 3/12	5/30 and 6/5 (died) *	First and second	Second	
Patient 4	2/25 and 3/1	3/5 and 3/8	3/15 and 3/20	First, second, and third	Second and third	

*Excluded hospitalization in which the patient died in the hospital.

In the example in Table 3.2, patient 1 has one index hospitalization and is not readmitted. Patient 2 has two index hospitalizations and zero readmissions because the time interval between the two hospitalizations is more than 30 days. Patient 3 has two index hospitalizations and one readmission because of returning within the 30-day window. The third hospitalization for patient 3 does not count as a readmission because it is beyond the 30-day window, and it does not count as an index hospitalization because the patient died, leaving no potential to return to the hospital. Patient 4 has three index hospitalizations, the latter two of which count as readmissions because they were both within the 30-day window. Aggregating across these four fictional patients gives a total of three readmissions (one from patient 3 and two from patient 4) associated with eight index hospitalizations (one from patient 1, two from patient 2, two from patient 3, and three from patient 4) for an overall readmission rate of 100 x 3/8 = 37.5%.

30-day readmission population cohorts. Readmission of patients who were recently discharged after hospitalization with AMI, pneumonia, heart failure, COPD, and elective THA/TKA represents an important, expensive, and often preventable adverse outcome (Jencks et al., 2009; Joynt & Jha, 2011; Kahn et al., 2015; Merkow et al., 2015; Prieto-Centurion et al., 2010; Weiss et al., 2007). The risk of readmission can be modified by the quality and type of care provided to these patients. Improving readmission rates is the joint responsibility of hospitals and clinicians. Health care reform has introduced a variety of incentive programs, such as readmissions, that are also being monitored closely by hospital leaders, policymakers, and payers. Under the HRRP, hospitals are penalized up to 3 percent of the base DRG for readmissions representative of conditions that were measured in this study (see Table 3.3). See Appendices A and B for a full listing of included *ICD-9-CM* codes for this study analysis.

Table 3.3

30-Day Readmission Cohort Measures and Definitions.

Dependent Variable Measure	Conceptual Definition	Operational Definition
Pneumonia Readmission	Readmitted patients, who during the index hospitalization had a primary diagnosis of pneumonia as specified by the hospital-coded discharge abstract using *ICD-9-CM* codes and reported in the hospital files submitted to Vizient. This condition is included in the HRRP and reported on the Hospital Compare website (medicare.gov).	A readmission within 30 days of the discharge date from an index hospitalization. Measured as a rate of pneumonia patients readmitted per total number of pneumonia patients discharged in 2016.
Heart Failure Readmission	Readmitted patients, who during the index hospitalization had a primary diagnosis of heart failure as specified by the hospital-coded discharge abstract using *ICD-9-CM* codes and reported in the hospital files submitted to Vizient. This condition is included in the HRRP and reported on the Hospital Compare website (medicare.gov).	A readmission within 30 days of the discharge date from an index hospitalization. Measured as a rate of HF patients readmitted per total number of heart failure patients discharged in 2016

Dependent Variable Measure	Conceptual Definition	Operational Definition
Acute Myocardial Infarction Readmission	Readmitted patients, who during the index hospitalization had a primary diagnosis of acute myocardial infarction as specified by the hospital-coded discharge abstract using *ICD-9-CM* codes and reported in the hospital files submitted to Vizient. This condition is included in the HRRP and reported on the Hospital Compare website (medicare.gov).	A readmission within 30 days of the discharge date from an index hospitalization. Measured as a rate of AMI patients readmitted per total number of AMI patients discharged in 2016.
Chronic Obstructive Pulmonary Disease Readmission	Readmitted patients, who during the index hospitalization had a primary diagnosis of chronic obstructive pulmonary disease as specified by the hospital-coded discharge abstract using *ICD-9-CM* codes and reported in the hospital files submitted to Vizient. This condition is included in the HRRP and reported on the Hospital Compare website (medicare.gov).	A readmission within 30 days of the discharge date from an index hospitalization. Measured as a rate of COPD patients readmitted per total number of COPD patients discharged in 2016.
Total Hip and Knee Arthroplasty (THA/TKA) Readmission	Readmitted patients, who during the index hospitalization had a primary diagnosis of THA/TKA as specified by the hospital-coded discharge abstract using *ICD-9-CM* procedure codes and reported in the hospital files submitted to Vizient. These elective procedure conditions are included in the HRRP and reported on the Hospital Compare website (medicare.gov).	A readmission within 30 days of the discharge date from an index hospitalization. Measured as a rate of THA/TKA patients readmitted per total number of THA/TKA patients discharged in 2016.

Hospital characteristics (covariate). Hospital factors may be broadly associated with readmissions and assist in describing the variation in size, resources required to treat patients, and nursing environments among hospitals. Different clinical and non-clinical reasons (i.e., bed supply, acuity or severity of patient illness, community resources) exist for variations in readmission rates across hospitals and geographic region.

Hospital characteristics are a source of variability on both nurse staffing and readmissions, thus should be considered in analysis to obtain more accurate estimates on the relationship between nurse staffing and readmission outcomes. To control for this confounding effect, hospital characteristics such as case mix index, hospital size (number of staffed beds), geographic region, and Magnet® status were included in the study (see Table 3.4).

Table 3.4

Hospital Characteristic Measures and Definitions.

Covariate Measure	Conceptual Definition	Operational Definition
Case Mix Index (CMI)	A federally determined methodology (DRG/MSDRG relative weight) for basing reimbursement and also used as a composite of a hospital's average level of patient acuity for comparison across hospitals.	Categorical variable computed by Vizient and provided as a specified value. Measured as CMI ranges grouped by 1.0-1.49; 1.5-1.9; 2.0 & over.
Hospital size (Number of staffed beds)	Total licensed beds in operation.	Categorical variable as a proxy measure of capacity. Reported to Vizient in the hospital files & used for comparison across hospitals. Measured as hospitals grouped by ≤ 250 beds, 251-499 beds, 500-749 beds, & ≥ 750 beds.
Geographic Region	A region designating a geographic populated area.	Categorical variable; reported to Vizient in the hospital files and used to compare differences. Measured as regions grouped by Mid-Atlantic, Mid-Continent, Midwestern, New England, Southeastern, & Western.
Magnet® Status	An American Nurses Credentialing Center recognition award of hospitals meeting the criteria for quality patient care, nursing excellence and innovations in professional nursing practice.	Categorical variable; A designation reported to Vizient by participating hospitals in the submitted hospital files. Non-Magnet hospital = 0, Magnet = 1.

Patient characteristics (covariate). The target population for this study was patients discharged from acute care hospitals affiliated with Vizient and a diagnosis of AMI, pneumonia, heart failure, COPD, elective total hip and total knee arthroplasty. Inclusion of selected demographic measures assists in better understanding the differences among groups associated with readmissions. Patient characteristics may have a direct or non-direct effect on both nurse staffing and readmissions and also affect homogeneity of patients in the hospital. To control for this confounding effect, patient characteristics such as sex, race, age, and length of stay were included in this study.

The patient characteristics of sex, race, and age represent a set of non-modifiable risk factors and were evaluated in a single year (see Table 3.5). Patient length of stay reflect clinical care or processes that are used to reflect efficient care management practices of hospitalized patients and were evaluated in a single year aggregate (see Table 3.5).

Table 3.5

Patient Characteristic Measures and Definitions.

Covariate Measure	Conceptual Definition	Operational Definition
Sex	The state of being male or female.	Categorical variable reported in the hospital files submitted to Vizient; Measured as male = 0 or female = 1 patients included in data set.
Race	A social-political construct reported by patients upon admission as ‘White, ‘Black’, ‘Hispanic’, or ‘Other’.	Categorical variable. Submitted to Vizient in the hospital files; Grouped and measured by White, Black, Hispanic, or Other in the data set.
Age	Chronological age of the patient.	Continuous and categorical variable; Determined by patient age on admission to the index hospitalization as calculated from the patient birthdate. Grouped and measured into sets of age ranges.
Length of Stay	Duration of a single episode of hospitalization.	Continuous and categorical variable; Length of index hospitalization is calculated by subtracting day of admission from day of discharge. Days between discharge and readmission is calculated by subtracting day of discharge from day of admission. Patient admitted and discharged the same day will have a length of stay as one. Measured as categorical groups of 1-3 days; 4-6 days; 7-10 days; 11-14 days; and 15 & Over.

Data Analysis

This study examined the association of acute care nurse staffing (NHPPD) on 30-day readmissions at the hospital/annual level. For control variables, several patient characteristics covariates were included. These covariates included patient sex, race, age, and length of stay that may be correlated to readmissions and accounted for the mix of patients in any given hospital. Hospital characteristics covariates included case mix index, number of beds, geographic region, and Magnet® status.

The data were obtained from the Vizient Operational Data Base and Clinical Data Base in an Excel file format. The two data bases were merged into a SPSS file and the data analysis was conducted in SPSS Version 24 statistical analysis package. Multiple data analytics was used to answer four research questions (RQ) and test a major hypothesis (H):

RQ1. What were the readmission rates within 30 days from hospital discharge for CMS-targeted conditions of interest and in total of combined targeted conditions?

Descriptive statistics (mean, median, and standard deviation for readmission rates and frequency for readmission and hospitalization cases) was used to summarize important characteristics associated with distribution of readmission rates within 30 days for AMI, pneumonia, heart failure, COPD, and elective total hip and knee arthroplasty. Non-parametric statistics do not assume any distributional properties and can be used for count data, binary data, categorical data and other non-normal distributions (Polit & Beck, 2008). The data were examined for missing values, outlier cases, and any unusual patterns.

A bivariate analysis was performed to investigate differences between each CMS condition by quarter and by each CMS condition by hospital size. Chi-Square was used to determine the statistical significance between each CMS condition by quarter and each CMS condition by hospital size and readmissions within 30 days from the index hospital discharge.

RQ2. What was the length of time between patients' index hospital discharge and readmission within 30 days for the CMS-targeted conditions and for the combined targeted conditions?

Descriptive statistics (mean, median, quartiles, and standard deviation) were used to address RQ2 and report important values of distribution between hospital discharge and readmission within 30 days among the CMS-targeted conditions. The data were examined for missing values, outlier cases, and any unusual patterns.

A bivariate analysis was performed to investigate differences between all patient and hospital covariates, NHPPD (quartiles), and each CMS condition with the interval of days (1-3 days, 4-7 days, 8-14 days, 15-21 days, and 22-30 days) from the index discharge and readmission. Chi-Square was used to determine the statistical significance between all patient and hospital covariates, NHPPD (quartiles), and each CMS condition with the interval days to readmission.

RQ3. What patient characteristics (sex, race/ethnicity, age and duration of index hospitalization) are associated with readmissions within 30-days of the CMS-targeted conditions of interest and the combined targeted conditions?

Prior to testing RQ3, descriptive statistics (mean, quartiles, standard deviation) were used to check variables of patient demographic characteristics, and length of stay among the CMS-targeted conditions.

The bivariate analysis also was performed to investigate correlations and differences between each of the patient demographic characteristics, length of stay and readmissions. Chi-Square was used to determine the statistical significance between readmissions and nominal covariates of patient characteristics. Pearson correlation (*r*) was used to examine correlations between patient characteristics and readmissions within 30 days of the index hospital discharge.

RQ3 was tested with multilevel logistic regression. A two-level regression model allowed for grouping of readmission outcomes within hospitals and including residuals at the patient and hospital level. Thus, the residual variance was partitioned into a between-hospital component (the variance of the hospital-level residuals) and within-hospital component (the variance of the patient-level residuals). The hospital residuals, referred to as the hospital effects, represent unobserved hospital characteristics that affect readmission outcomes. It is these unobserved variables that lead to correlation between readmission outcomes for patients in the same hospital.

RQ4. What hospital characteristics (case mix index, hospital size, geographic region, and Magnet® status) were associated with readmissions within 30 days?

Prior to testing RQ4, descriptive statistics (median, quartiles, variances) were used to check variables of hospital characteristics among the CMS-targeted conditions. The data were examined for missing values, outlier cases, and any unusual patterns.

The RQ4 bivariate analysis also was performed to investigate correlations and differences between each of the hospital characteristics and the readmissions (yes/no) for each of the CMS-targeted conditions. A Chi-Square analysis was used to determine statistical significance between the outcome variable of readmissions and hospital characteristic covariates. For hospital characteristics, Pearson correlation (*r*) was used to examine correlations between hospital characteristics and readmissions. RQ4 was tested with multilevel logistic regression.

H: Adult patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days, controlling for patient and hospital characteristics.

Before beginning the multilevel logistic regression analysis, a bivariate analysis using Chi-Square was performed as an important step to examine relationships among the variables and was used to assist in determining variables for inclusion in the multivariate model. Pearson correlation (*r*) was used between the independent variable (NHPPD) and the outcome variables (readmissions of AMI, pneumonia, CHF, COPD, elective THA & TKA).

Multilevel logistic regression analysis was employed to test the hypothesis that adult patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days, controlling for patient and hospital characteristics. The data was examined for unusual and missing values, empty or small cells, and variation of the continuous data. Multicollinearity was examined among the nurse staffing variable (NHPPD) and four hospital characteristics variables (CMI, hospital size, geographic region, and Magnet® status), and patient characteristics by using correlations, condition index, and the variance inflation factor (VIF).

Vittinghoff and McCulloch (2006) suggested a rule of thumb for the sample size needed for a regression model, which is at least 10 events per predictor variable. Based on this, the sample size needed is 310 readmission events (Vittinghoff & McCulloch, 2006). Therefore, the sample size of 5,578 readmission events from 42,876 patient discharge encounters in the dataset was sufficient to evaluate the relationship between nurse staffing and readmission variables.

Outcome data associated with patient-level data nested within groups of hospital data may result in statistical dependency (O'Dwyer & Parker, 2014). When examining the relationships between group characteristics and individual outcomes because each individual in a group is assigned the same value for a group characteristic, a statistical dependency can occur and ultimately lead to incorrect statistical conclusions (O'Dwyer & Parker, 2014; West et al., 2007). To avoid this dependency a multilevel regression analysis was used to analyze readmission outcomes with the fixed factor patient-level and hospital-level characteristics and the random factor of hospital ID. Multilevel regression modeling does not correct bias in the regression coefficient estimates compared with an ordinary least squares used in standard regression models; however, it produces unbiased estimates of the standard errors associated with the regression coefficients when the data are nested, and allows hospital (group) characteristics to be included in models of readmission (individual) outcomes (O'Dwyer & Parker, 2014; West et al., 2007).

There are several tests that were examined and significant results discussed and reported. These included the coefficient, standard error associated with the coefficients, degrees of freedom for each of the tests of the coefficients, significance level, the odds ratio (*OR*) and a 95% confidence interval for *OR* for all variables. The Akaike information criterion (*AIC*) and Bayesian information criterion (*BIC*) provided a way to assess the fit of the model based on the log-likelihood value. Due to the presence of random effects and different covariance structures, diagnostic methods are part of the model-building process (West et al., 2007).

Reliability and validity of administrative data. Reliability of administrative data related to the variables of nurse staffing and readmissions is in the reproducibility, specificity, and clarity of the data. Clarity in specificity of Excel data fields supports the instrument's ability to measure what it is supposed to measure (Waltz, Strickland, & Lentz, 2010). The data required and collected are consistent with specific and typical hospital demographic, workforce tracking, and discharge data required by CMS and other payers for billing and outcomes measurement purposes.

Nurse staffing hours per patient day (NHPPD) has been in use in hospitals for decades to determine adequate nurse staffing levels to care for patients. The mathematical calculation has been deemed valid and reliable by content experts such as: Kirby (2015), the National Database for Nursing Quality Indicators (n.d.), and the American Nurses Association and endorsed by the National Quality Forum NQ# 02015 (n.d.), thus providing assurance of validity and reliability.

Operational definitions are an important criterion for content validity that must reflect the purpose of the research, be mutually exclusive, independent, and derived from a classification system (Waltz et al., 2010). Operational definitions of the outcome variables are consistent to the CMS measures and described and provided in Tables 3.3, 3.4, 3.5, and appendices A and B. Overall validity was supported and ensured by direct data transfer from Vizient data repositories into an Excel-based spreadsheet data collection tool, reducing the potential for common source error in transcription of existing data.

Limitations

An inherent limitation of administrative claims data is the reliance on data originally intended for billing purposes. The coding may be inaccurate through error or under-coding of certain diagnoses based upon inadequate documentation in the medical record and threaten the reliability of the data. All administrative claims data may not be affected to the same degree within and across hospitals in regard to data reliability.

Although an index hospitalization was defined as any inpatient hospitalization that was eligible to have subsequent admission to the same hospital, data limitations do not allow tracking patients from one hospital to another. Patient comorbidity conditions are not included in this study although generally associated with worse health outcomes, more complex clinical management, and increased health care costs (Martsolf et al., 2014; Needleman et al., 2006; Southern & Arnsten, 2015; Stone & Hoffman, 2010). Given the effect of clinical management of patients with comorbid conditions, this is a study limitation.

Unit-level nurse staffing and hospital-level measures are merged to the patient-level because the readmission outcome indicator was obtained from discharge abstract data. In general, patient discharges and nurse staffing reflect more variation at the unit level than at the hospital level. The aggregation at the patient-level could bias estimates of the relationships between nurse staffing and readmissions within 30 days. Variation in State laws and competitive conditions are not measured in this study but may exist as a limitation. Further, the annual data used all payers and all adult patients but were limited to hospitals participating in the Vizient collaborative and submitting data to both the Operational Data Base and the Clinical Data Base, which may not be generalizable to all Vizient hospitals and hospitals nationwide.

Human Subjects

The study did not pose risks to the patients. The various system characteristics of hospital characteristics, nurse staffing and patient characteristics on 30-day readmission outcomes were examined through secondary, de-identified administrative data only. A Midwestern academic medical center Institutional Review Board (IRB) application was submitted and the project was certified as not-human subjects research. Upon approval from the

IRB, a copy of the IRB application was provided to Vizient (pursuant to their Data Request Application). Following these approval steps, the Vizient data sets for 2016 were requested and obtained. The data were transmitted via a secure file to a password protected website. Upon receipt, the data were stored in a secure folder provided at the Midwestern academic medical center.

CHAPTER 4

RESULTS

This chapter describes the results in two sections namely, “Description of Patient and Hospital Characteristics” and the “Examination of the Research Questions and Testing the Hypothesis”. The study addressed the following aims to: (a) describe patient characteristics, readmission rates, and the interval from patients’ index hospital discharge to readmission within 30 days from hospital discharge for specific CMS-targeted conditions of interest and overall readmission rates for those conditions; (b) determine the relationships between patient demographic characteristics (sex, race, age), hospital characteristics, and readmission rates by CMS-targeted conditions of interest and the combined targeted conditions overall; and (c) determine whether nurse staffing was associated with readmissions within 30 days of hospital discharge. For the third aim, the hypothesis was tested that acute care hospitals with higher nurse staffing levels are less likely than those with lower levels of nurse staffing to have a readmission within 30 days of an index hospital discharge.

Patient Characteristics

This study analyzed 42,876 patient discharge encounters, including the medical diagnosis of acute myocardial infarction (12.0%), pneumonia (14.4%), congestive heart failure (27.0%), chronic obstructive pulmonary disease (12.3%), and hip and knee arthroplasty (34.2%). The mean age of patients in the sample was 66.5 years (*SD* = 14.5). Patients’ age was categorized as 18-34y, 35-44y, 45-54y, 55-64y, 65-74y and ≥ 75y, with the largest percentage of patients in the oldest group (28.5%) (see Appendix G). Nineteen percent of the patients were under 54 years of age. More patients were female (51.7%).

The majority of patients were White (69.8%), followed by Black patients (20.2%). The race/ethnicity group of Other (6%) is an aggregation of Asian; Hawaiian/Pacific Islander; Native American/Eskimo; multiracial; unavailable; unknown; and other. Hispanic (4%) is the smallest race/ethnicity patient group. The distribution of length of stay was skewed to the right (skewness = 42.2; kurtosis = 4500.6). Median length of stay for patients' index hospitalization at the 30 study hospitals was 3.0 days (2 days to 5 days, at the 25th and the 75th percentiles, respectively) as presented in Table 4.1. Most patients had a hospitalization lasting 1 to 3 days (61.2%).

Table 4.1

Patient Index Hospitalization (N=42876)

	Mean (SD)	***25th Percentile***	***50th Percentile (Median)***	***75th Percentile***	***Skewness / Kurtosis***
Length of Stay	4.04 (5.08)	2.00	3.00	5.00	42.19 4500.63

There were racial differences in the distribution of diagnosis and length of index hospital stay (Figure 4.1). For example, among patients with an acute myocardial infarction, Black patients had a longer hospital stay, median length of 4 days versus 3 days for all other racial/ethnic groups. This pattern varied for different conditions with different racial groups. Hispanic patients with COPD had a median length of 4 days versus 3 days for all other racial/ethnic groups. Among hip/knee patients, the racial/ethnic groups of Other and Hispanic patients had a median length of 4 days versus 3 days for Black and White patients. Patient characteristics (i.e., age, sex, race/ethnicity, index hospital length of stay) are summarized by hospital size (Appendix H) and CMS conditions (Appendix I).

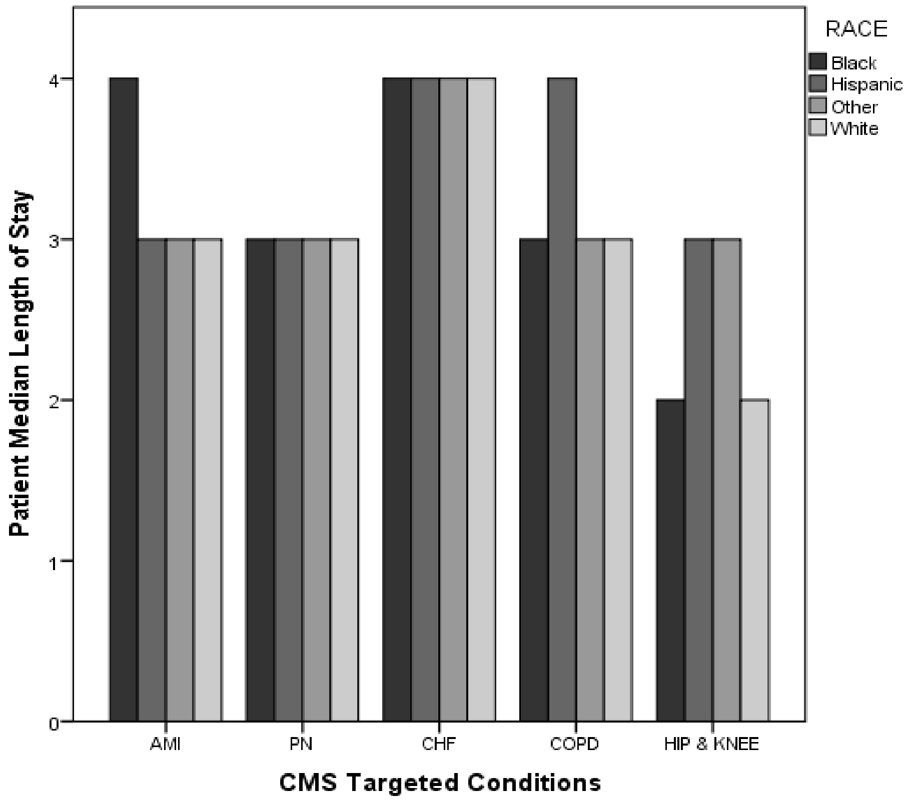


Figure 4.1. Median Length of Stay by Race/Ethnicity and CMS Conditions

Hospital Characteristics

The 30 hospitals in this study were in six geographic regions of the U.S. (Mid-Atlantic, Mid-Continent, Midwestern, New England, Southeastern, and Western). The States included within each geographic region are defined by Vizient (Appendix J). About 40% of the study hospitals were Magnet designated. Seventeen (57%) hospitals reported a Case Mix Index of 2.0 or greater (Appendix K). Six (20%) hospitals had 250 or fewer staffed beds; 6 (20%) hospitals had 251-499 staffed beds; 15 (50%) hospitals were 500-749 staffed beds; and 3 (10%) had 750 beds or more. Not all hospitals submitted data for all 4 quarters; however, 83% of participating hospitals reported data for 3 quarters or more. Thirty hospitals provided data for 42,876 discharge encounters over 102 quarters for patients 18 years of age and older. Distribution of the hospital characteristics for the 42,876 discharge encounters is presented in Appendix L.

Readmission Rates for CMS-targeted Conditions

Multiple statistical analyses were performed to answer the four research questions and to test the study hypothesis. Descriptive statistics addressed RQ1 of the readmission rates within 30 days from hospital discharge for each CMS-targeted condition and for all targeted conditions. The overall readmission rates for the CMS-targeted conditions were 13.0%, ranging from 4.3% for hip and knee arthroplasty to 20.5% for congestive heart failure (see Table 4.2).

Table 4.2

Readmission Rates Within 30-Days of Index Hospital Discharge

CMS-targeted Conditions	**Patients (*n*)**	**Readmitted Patients (*n*)**	**Readmission Rate (%)**
AMI	5,164	790	15.3
Pneumonia	6,167	849	13.8
CHF	11,592	2,373	20.5
COPD	5,294	942	17.8
Hip & Knee Arthroplasty	14,659	624	4.3
Total	42,876	5,578	13.0

Note. Readmission rates calculated at patient level. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

Further examination of each CMS condition by quarter revealed the readmission rate for AMI ranged from 13.1% to 17.1%; pneumonia ranged from 12.8% to 15.3%; CHF ranged from 19.2% to 21.5%; COPD from 17.0% to 18.2%; and, hip and knee from 3.9% to 4.7%. A bivariate analysis using Chi-Square showed that, except for AMI, χ^2 (3, N=4,374) = 8.91, p =.03, there were no significant differences in distribution of quarterly readmission rates for the CMS conditions. A comparison summary of the distribution of readmission rates by condition and quarter is provided in Appendix M.

Hospital size is a surrogate measure for assessing capacity to admit patients for care and is identified as a factor in hospital outcomes. There was little variation in readmission rates across different hospital sizes (Appendix N). Chronic conditions such as, congestive heart failure and chronic obstructive pulmonary disease, had the highest readmission rates across hospital all sizes. Patients with elective hip and knee arthroplasty, generally considered a healthier population, had the lowest readmission rates across all hospital sizes. For example, in hospitals with fewer than 250 beds, those with hip and knee surgery had a readmission rate of 2.8%, much lower than those with COPD (15.3%), pneumonia (11.7%), or AMI (13.0%), χ^2 (4, N=6,479) = 255.27, $p < .001$; in hospitals 251 to 499 beds, patients with hip and knee surgery had a readmission rate of 5.3%, much lower than those with COPD (18.7%), pneumonia (12.9%), or AMI (16.3%), χ^2 (4, N=7,950) = 296.16, $p < .001$; hospitals 500 to 749 beds, hip and knee surgery patients had a readmission rate of 4.9% compared with COPD (17.5%), pneumonia (14.8%), or AMI (15.9%), χ^2 (4, N=19,463) = 714.38, $p < .001$; and in hospitals greater than 750 beds, hip and knee patients had a readmission rate of 3.1%, much lower than those with COPD (20.0%), pneumonia (14.9%), and AMI (14.2%), χ^2 (4, N=6,781) = 438.98, $p < .001$.

Time from Index Discharge to Readmission

RQ2 examined the length of time between patients' discharge from the index hospitalization and their readmission within 30 days, overall and for each CMS-targeted condition. The distribution of the interval days from the index hospital discharge to readmission found more patient readmissions occurred earlier in the 30-day window. Table 4.3 depicts the mean and median interval from the index hospital discharge to readmission of approximately 12 days (5 days to 19 days, 25th percentile to 75th percentile, respectively).

Table 4.3

Interval Time to Readmission (N=42,876)

	Mean (SD)	***25th Percentile***	***50th Percentile (Median)***	***75th Percentile***	***Skewness / Kurtosis***
Days to Readmit	12.66 (8.63)	5.00	12.00	19.00	.32 -1.01

The time interval between discharge and readmission serves as a useful indictor of hospital quality performance to evaluate for readmissions that are potentially preventable within the 30-day window. Early readmissions (within seven days) served as a surrogate measure for readmissions that may have been related to the patient's clinical status/readiness for discharge. To further elucidate the days from index hospital discharge to readmission across the CMS conditions, intervals were categorized into 1-3 days, 4-7 days, 8-14 days, 15-21 days, and 22-30 days. From some anecdotal observations, patients with poor pain control from surgical procedures may return within seven days whereas, patients being treated with diuretics for CHF or steroids for COPD may return more than 14 days out from discharge but within the 30-day window. Overall, 34.7% (1,938 of 5,578 readmissions) of patients discharged with a diagnosis of one of the five CMS-targeted conditions were readmitted in seven days or less, similar for categories of age, race/ethnicity, and hospital size.

A bivariate analysis using Chi-Square showed that although elective hip and knee patients had lower readmission rates compared to other CMS-targeted conditions, 50% of those readmissions occurred within seven days (χ^2 (4, N=313), p < .001). In contrast, 30% of both congestive heart failure and chronic obstructive pulmonary disease patients were readmitted within seven days (χ^2 (4, *N*=738), $p < .001$ and χ^2 (4, *N*=272), $p < .001$ respectively). Similar patterns in interval to readmission were observed geographically, except for hospitals in the New England region where patients were admitted sooner. The longer the index hospitalization, the earlier the readmission tended to be. For example, an index hospitalization of 15 days or greater was associated with more readmissions within seven days. However, the association was not statistically significant. Hospitals in the highest NHPPD quartile of 13.33-16.47 had lower rates of readmission within one week of discharge compared to hospitals in the lowest NHPPD quartile of 6.41-11.8 (34.1% vs. 37.5%, χ^2 (3, *N*=1,938), $p = .038$), a trend that reversed over the 30-day post-discharge period.

Magnet designated hospitals had a lower early readmission rate. Hospitals with CMI of 2.0 or greater had the lowest rates of early readmission within 7 days compared to the two other CMI categories (33.6% vs. 38.9.0% vs. 35.3%, $p < .001$). A descriptive summary of the distribution differences in the interval days from discharge to readmission among all variables is provided in Appendix O.

Association between Patients' Demographic Characteristics and Readmissions

RQ3 asks, "Which patient characteristics (sex, race, age and duration of index hospitalization) are associated with readmissions within 30 days of discharge?" For interpretative purposes relevant to the clinical setting, age and length of stay were converted into categorical variables. A study by Martsolf et al. (2014) was used as reference to determine age categories since their study addressed the effect of nurse staffing on quality of care and used similar patient-level covariates from hospital financial and discharge utilization data in three states from nonfederal, general acute care, and non-rehabilitation hospitals.

Bivariate analyses using Chi-Square showed significant differences in readmissions within 30 days of discharge by patient demographic characteristics (Table 4.4). Significant

Table 4.4

Readmissions by Patient Characteristics (N = 42,876)

	Readmissions			**Chi-Square**
	No	**Yes**	**%**	
Age Range in Years				
18-44	2,524	420	14.3	
45-54	4,528	708	13.5	54.88**
55-64	9,695	1,359	12.3	
54-74	10,088	1,319	11.6	
≥ 75	10,463	1,772	14.5	
Sex				
Male	17,781	2,933	14.2	45.82**
Female	19,517	2,645	11.9	
Race / Ethnicity				
Black	7,175	1,492	17.2	
Hispanic	1,481	243	14.1	181.14**
Other	2,288	270	10.6	
White	26,354	3,573	11.9	
Index Hospital Length of Stay (Range in Days)				
1-3	23,770	2,490	9.5	
4-6	8,497	1,760	17.2	
7-10	3,262	862	20.9	793.55**
11-14	998	269	21.2	
≥ 15	771	197	20.4	

Note: ***p* < .001.

differences were noted for some demographic characteristics (i.e., sex, race/ethnicity, and length of stay) and not for other patient demographics (i.e., age) in hospital readmissions rates. For example, Blacks had significantly higher readmission rates than Whites (17.2% v. 11.9%, χ^2 (3, *N*=42,876) = 181.14 *p* < .001) while age had significant differences in the five age groups

(14.3% vs. 13.5% vs. 12.3% vs. 11.6% vs. 14.5%, χ^2 (4, *N*=42,876) = 54.88 $p < .001$), the youngest (18-44) and oldest (≥ 75) age patients had no difference in readmission rates (14.3% v. 14.5%). Females had a lower readmission rate than males, 11.9% versus 14.2%, χ^2 (1, *N*=42,876) = 45.82, $p < .001$.

Multilevel logistic regression was performed to assess the associations between patient characteristics (i.e., age, sex, race, and length of stay during index hospitalization) and readmission within 30 days of index hospital discharge, controlling for categorical nurse staffing and hospital characteristics. All 42,876 cases were included in the regression model. Assumptions using Cook's distance confirmed there were no outliers or influential values. There were no multicollinearity concerns, presenting tolerance values above .10 and variance influence factor values less than 10.

The patient characteristics of age, sex, race, and length of stay were entered as fixed effects against the dichotomous target of readmission in the model. CMS conditions (i.e., AMI, pneumonia, CHF, COPD, and hip and knee arthroplasty) were included with patient characteristics as a fixed effect since these conditions directly affect the patient outcome, i.e., the likelihood of readmission. Hospital ID was used as random effect to account for the clustering of more than one unit within each hospital. The Akaike Corrected and Bayesian information criterion were used to assess the fit of the model with the goal to choose the simplest model in the final model for the study (West et al., 2007).

A multilevel logistic regression analysis table on the fixed effects of patient characteristics against the target of readmissions is presented in Table 4.5. The odds of Blacks being readmitted were nearly 1.18 times greater when compared to Whites (*95% CI* [1.10, 1.28],

$p < .001$), controlling for categorical nurse staffing and hospital characteristics. The odds of patients in Other race/ethnicity being readmitted were 20% less when compared to Whites (*95% CI* [0.69, 0.92], $p = .002$). Hispanics had 9% greater odds of readmission when compared to Whites but this result was not statistically significant (*95% CI* [0.93, 1.25], $p = .316$).

Table 4.5

Multilevel Logistic Regression of Patient Characteristics on Readmissions

Variable	***t***	***OR (95% CI)***	***p*-value**
Sex			
Male	4.48	1.14 (1.08, 1.21)	**< .001**
Female (Ref.)			
Race/Ethnicity			
Blacks	4.45	1.18 (1.10, 1.28)	**< .001**
Hispanics	1.00	1.08 (0.93, 1.25)	.316
Other	-3.16	0.80 (0.69, 0.92)	**.002**
White (Ref.)			
Age Range in Years			
18-44 (Ref.)			
45-54	0.71	1.05 (0.92, 1.20)	.479
55-64	-0.04	1.00 (0.88, 1.13)	.972
65-74	-0.67	0.96 (0.85, 1.08)	.506
75 & over	-0.23	0.99 (0.87, 1.11)	.817
Length of Stay (Days)			
1-3 (Ref.)			
4-6	9.90	1.42 (1.32, 1.52)	**< .001**
7-10	10.82	1.64 (1.50, 1.79)	**< .001**
11-14	6.49	1.61 (1.40, 1.86)	**< .001**
15 & over	4.75	1.49 (1.27, 1.76)	**< .001**
CMS Conditions			
AMI	20.67	3.42 (3.04, 3.84)	**< .001**
Pneumonia	18.77	2.96 (2.64, 3.32)	**< .001**
CHF	29.17	4.47 (4.05, 4.95)	**< .001**
COPD	24.73	4.08 (3.65, 4.56)	**< .001**
Hip & Knee Arthroplasty (Ref.)			

Note: Abbreviations: OR, odds ratio; AMI, acute myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.
Significant *p* values are shown in boldface, controlling for nurse staffing quartiles and hospital characteristics (i.e., size, geographic region, CMI, and Magnet®).
Information criterion: *AIC* = 224,049.00; *BIC* = 224,057.67. N = 42,876.

The duration or length of the hospital stay was significantly associated with readmissions within 30 days of discharge. The odds of being readmitted were 1.42 times greater for patients who stayed for 4-6 days than those who stayed for 1-3 days (*95% CI* [1.32, 1.52], $p < .001$), controlling for categorical nurse staffing and hospital characteristics; the odds were 1.64 times greater for being readmitted after 7-10 days length of stay compared to 1-3 days (*95% CI* [1.50, 1.79], $p < .001$); for a length of stay of 11-14 days the odds were 1.61 times greater compared to 1-3 days (*95% CI* [1.39, 1.86], $p < .001$); and, for patients who stay 15 days and longer the odds for readmission were 1.49 times greater compared to 1-3 days (*95% CI* [1.26, 1.76], $p < .001$), controlling for categorical nurse staffing and hospital characteristics.

Compared to women, the odds for men were nearly 1.14 times greater for being readmitted (*95% CI* [1.08, 1.21], $p < .001$), controlling for categorical nurse staffing and hospital characteristics; and, the odds of patients diagnosed with chronic conditions of AMI, Pneumonia, CHF, and COPD being readmitted were nearly 3.0 to 4.5 times greater than patients that had a total hip or knee arthroplasty procedure, controlling for categorical nurse staffing and hospital characteristics. Age did not have a statistical association with readmissions, controlling for categorical nurse staffing and hospital characteristics.

Association between Hospital Characteristics and Readmissions

RQ4 considered what categorical hospital characteristics (i.e., case mix index, size, geographic region, and Magnet®-designation) were associated with readmissions within 30 days of discharge. Bivariate analyses using Chi-Square showed significant differences in readmissions within 30 days of hospital discharge by hospital characteristics (see Table 4.6).

Table 4.6

Readmissions by Hospital Characteristics (N=42,876)

	Readmissions			**Chi-Square**
	No	**Yes**	**%**	
Case Mix Index				43.09***
1.0-1.49	5,337	638	10.7	
1.5-1.99	9,240	1,534	14.2	
2.0 & Over	22,721	3,406	13.0	
Hospital Size (Staffed Beds)				58.99***
≤ 250	5,787	692	10.7	
251-499	7,950	1,294	14.0	
500-749	16,789	2,683	13.8	
≥ 750	6,781	909	11.8	
Geographic Region				18.18*
Mid-Atlantic	11,184	1,623	12.7	
Mid-Continent	7,048	972	12.1	
Midwestern	2,969	428	12.6	
New England	3,253	483	12.9	
Southeastern	7,825	1,279	14.0	
Western	5,019	793	13.6	
Magnet® Designation				6.19**
Non-designated	20,648	3,187	13.4	
Designated	16,650	2,391	12.6	

Note: Readmission rates calculated at patient level. **p* = .003; ***p* = .013; ****p* < .001.

Patients discharged from hospitals with the lower range of Case Mix Index had a significantly lower readmission rate than the other two categories (10.7% vs. 14.2% vs. 13.0%, χ^2 (2, *N*=42,876) = 43.09, $p < .001$). Patients discharged from smaller (≤ 250 beds) and larger (≥ 750 beds) hospitals had significantly lower readmission rates of 10.7% and 11.8% than those in hospitals with 251-499 beds and 500-749 beds with 14.0% and 13.8% respectfully (χ^2 (3, *N*=42,876) = 58.99, $p < .001$). Patients in the Southeastern and Western geographic regions had the highest readmission rates of 14.0% and 13.6%, otherwise the remaining four regions were similar (χ^2 (5, *N*=42,876) = 18.18, $p = .003$). Differences in readmissions were also found in patients discharged from Magnet® hospitals (χ^2 (1, N=42,876) = 6.19, p = .013). Patients discharged from non-Magnet® hospitals had a 0.8% higher readmission rate than Magnet® hospitals.

Multilevel logistic regression was performed to assess the associations between hospital characteristics (case mix index, hospital size, geographic region, and Magnet® status) and readmissions within 30 days of hospital discharge, controlling for categorical nurse staffing and patient characteristics. A total of 42,876 cases were included in the regression model. A correlation test was performed and noted case mix index had a strong Pearson correlation between readmissions and hospital size (r = .774, p < .001). However, tolerance and variance influence factor values were placed within the recommended range.

Because each hospital characteristic was being assessed for association with readmission, all hospital characteristics were entered into the multilevel logistic regression model as fixed effects against the dichotomous variable of readmissions, controlling for categorical nurse staffing and patient characteristics. Hospital ID was used as a random effect to account for the clustering of more than one unit within the hospital. Testing of all hospital characteristics against readmissions within 30 days did not provide statistically significant results in the model. A multilevel regression analysis table on hospital characteristics is shown in Appendix P.

Association between Nurse Staffing Levels and Readmissions

The primary aim of the study was to investigate whether patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days of their index hospital discharge. NHPPD, as the primary variable of interest, was analyzed as a continuous variable and a categorical variable (quartiles) against readmissions using *t* test and Chi Square test for bivariate comparison with readmissions.

Distribution of NHPPD were normal to conduct an independent *t*-test. The assumption of homogeneity of variances was tested and satisfied via Levene's *F* test, F (42,874) = 1.325, p = .250. The independent samples *t*-test showed that hospital NHPPD was statistically different in readmitted patients and non-readmitted patients, t (42,874) = -2.936, p = .003. Non-readmitted patients were discharged from hospitals with lower NHPPD (M = 12.13), as compared to readmitted patients (M = 12.22). Although statistically significant, the mean difference of 0.09 NHPPD was clinically trivial.

Bivariate analyses with the categorical NHPPD variable using Chi-Square revealed significant differences in hospital NHPPD quartiles for patient readmissions and non-readmissions within 30 days of hospital discharge as shown in Table 4.7 (χ^2 (3, N = 42,876) = 13.98, p = .003). The highest staffing levels (13.33-16.47) had higher readmission rates compared to the three lower quartiles (14.1% vs 12.5% vs. 12.8% vs. 12.7%). There was a significant but small effect of NHPPD between readmission and non-readmission (Phi value = .018 and Cramer's V value = .018, p = .003).

Table 4.7

Readmissions by Nursing Hours per Patient Day (NHPPD; N=42,876)

	Readmissions			**Chi-Square**
	No	**Yes**	**%**	
NHPPD				13.98*
6.41-11.18	8,639	1,261	12.7	
11.26-12.33	10,423	1,533	12.8	
12.35-13.32	9,518	1,356	12.5	
13.33-16.47	8,718	1,428	14.1	

Note: *p = .003

Multilevel logistic regression was used to test the association between NHPPD and readmissions within 30 days of the index hospital discharge, controlling for patient and hospital characteristics. Two models were performed. Model 1 included a continuous variable of NHPPD, and Model 2 contained a categorical variable of NHPPD. The multilevel logistic regression model for the analysis was used to adjust for variation due to different hospitals and patients. Hospital ID was used as the random effect to account for the clustering of more than one unit within each hospital.

Cook's distance confirmed there were no outliers or influential values. Multicollinearity testing was performed and no concerns were identified, as reported in RQ3 and RQ4. Patient and hospital characteristic covariates were included in the models to test the hypothesis. The Akaike Corrected and Bayesian information criterion were used to assess the fit of the model (West et al., 2007).

Model 1 with Continuous NHPPD. The variables entered into the two-level binary logistic regression Model 1 as fixed effects included NHPPD (continuous variable) on readmissions within 30 days of index hospital discharge.

NHPPD as a continuous variable (Model 1) was significantly associated with patient readmissions (Table 4.8). The *ORs* for patient characteristics derived from Model 1 were similar with those in the model with categorical NHPPD reported in Table 4.5. Patient age was not associated with readmissions within 30 days. The odds for males were 1.14 times greater to be readmitted compared to females (*95% CI* [1.08, 1.21], $p < .001$). The odds of Blacks being readmitted were 19% greater when compared to Whites (*95% CI* [1.10, 1.28], $p < .001$). The odds of race/ethnicity category of Other being readmitted were 20% less when compared to

Whites (*95% CI* [0.70, 0.92], p = .002). Similar to results shown in Table 4.5, there was no statistical association to the odds of being readmitted for Hispanics.

Table 4.8

Multilevel Logistic Regression of NHPPD on Readmissions (Model 1)

Variable	***t***	***OR (95% CI)***	***p* value**
NHPPD (Continuous)	2.56	1.04 (1.01, 1.08)	**.010**
Sex			
Male	4.47	1.14 (1.08, 1.21)	< **.001**
Female (Ref.)			
Race/Ethnicity			
Blacks	4.49	1.19 (1.10, 1.28)	< **.001**
Hispanics	1.05	1.08 (0.93, 1.26)	.293
Other	-3.11	0.80 (0.70, 0.92)	**.002**
White (Ref.)			
Length of Stay (Days)			
1-3 (Ref.)			
4-6	9.89	1.42 (1.32, 1.52)	< **.001**
7-10	10.81	1.64 (1.50, 1.79)	< **.001**
11-14	6.45	1.61 (1.39, 1.86)	< **.001**
15 & Over	4.74	1.49 (1.26, 1.76)	< **.001**
CMS Conditions			
AMI	20.64	3.41 (3.03, 3.83)	< **.001**
Pneumonia	18.73	2.95 (2.64, 3.31)	< **.001**
CHF	29.13	4.46 (4.04, 4.94)	< **.001**
COPD	24.73	4.08 (3.65, 4.56)	< **.001**
Hip & Knee Arthroplasty (Ref.)			
Hospital Size			
≤ 250 Beds (Ref.)			
251-499 Beds	2.20	1.67 (1.06, 2.65)	**.027**
500-749 Beds	1.54	1.40 (0.91, 2.15)	.124
≥ 750 Beds	1.14	1.33 (0.81, 2.16)	.256
Magnet® Designation			
Non-Designated	2.01	1.15 (1.00, 1.31)	**.044**
Designated (Ref.)			

Note: OR, odds ratio; AMI, acute myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease. Significant p values are shown in boldface; controlled for all patient (i.e., age, sex, race, length of stay, and CMS conditions) and hospital characteristics (i.e., size, geographic region, CMI, and Magnet®) in the model.
Model information criterion: *AIC* = 224,030.60; *BIC* = 224,039.26.
N=42,876.

The length of stay remained significantly associated with readmissions within 30 days of hospital discharge. The odds of being readmitted were 1.42 times greater for patients who stay 4-6 days than those who stayed for 1-3 days (*95% CI* [1.32, 1.52], $p < .001$); the odds were 1.64 times greater for being readmitted after 7-10 days length of stay compared to 1-3 days (*95% CI* [1.50, 1.79], $p < .001$); for a length of stay of 11-14 days the odds were 1.61 times greater compared to 1-3 days (*95% CI* [1.39, 1.86], $p < .001$; and, for patients who stay 15 days and longer the odds for readmission were 1.49 times greater compared to 1-3 days (95% CI [1.26, 1.76], $p < .001$.

The odds of patients diagnosed with chronic conditions of AMI, Pneumonia, CHF, and COPD being readmitted were statistically significant ($p < .001$) and similar to previous findings in Table 4.5. The odds of patients diagnosed with these chronic diseases being readmitted were 3.0 to 4.5 times greater compared to hip and knee patients.

For the covariates of hospital characteristics, only hospital size and Magnet® designation were statistically associated with readmissions. Patients discharged from hospitals with 251-499 beds had 67% greater odds for being readmitted compared to hospitals with 250 beds or less (*95% CI* [1.06, 2.65], $p = .027$). The remaining two categories of hospital size (500-749 beds and ≥ 750 beds) were not statistically associated with readmissions within 30 days. The odds of hospitals that are not Magnet®-designated were 1.15 times greater for patients being readmitted compared to Magnet®-designated hospitals (*95% CI* [1.00, 1.31], $p = .044$).

Model 2 with Categorical NHPPD. The variables entered into the two-level binary logistic regression Model 2 as fixed effects included NHPPD (quartiles) on readmissions within 30 days of index hospital discharge.

A summary of the association between NHPPD and readmissions within 30 days of the index hospital discharge in Model 2 are presented in Table 4.9. The associations between patient and hospital characteristics (control variables) and readmissions have been reported in Table 4.5 and Appendix P.

The odds of being readmitted for patients at hospitals with NHPPD 12.35-13.32 were 15% less when compared to patients at hospitals with the highest staffing quartile of 13.33-16.47 (*95% CI* [0.76, 0.96], *p* = .009), controlling for patient and hospital characteristic covariates. The odds of being readmitted for patients at hospitals with NHPPD 11.26-12.33 were 12% less when compared to NHPPD 13.33-16.47 (*95% CI* [0.78, 0.99], *p* = .048). Patients discharged from hospitals with the lowest NHPPD quartile 6.41-11.18 had 23% less odds of being readmitted (*95% CI* [0.63, 0.93], *p* = .008) compared to the highest NHPPD quartile 13.33-16.47.

Table 4.9

Multilevel Logistic Regression of NHPPD on Readmissions (Model 2)

Variable	***t***	***OR (95% CI)***	***p* value**
NHPPD			
6.41-11.18	-2.63	0.77 (0.63, 0.93)	**.008**
11.26-12.33	-1.98	0.88 (0.78, 0.99)	**.048**
12.35-13.32	-2.62	0.85 (0.76, 0.96)	**.009**
13.33-16.47 (Ref.)			

Note: OR, odds ratio; Significant *p* values are shown in boldface; controlled for all patient (i.e., age, sex, race/ethnicity, index length of stay, and CMS conditions) and hospital characteristics (i.e., CMI, hospital size, geographic region, and Magnet®-designation) in the model.
Model information criterion: *AIC* = 224,049.00; *BIC* = 224,057.67.
N=42,876.

Summary

Akaike and Bayesian information criterion showed that Model 1 with NHPPD as a continuous model and Model 2 with NHPPD as a categorical had a similar fit (*AIC* = 224,030.60 vs. 224,049.00; *BIC* = 224,039.26 vs. 224,057.67). Based on the trivial differences in the *AIC* and *BIC* a determination of which model is better was not possible.

This study found that acute care hospital nurse staffing levels in Model 1 with continuous NHPPD were significantly associated with patient readmissions (p = .010). Model 2 with categorical NHPPD also showed significant association with patient readmissions and allowed for comparison between the highest nurse staffing quartile of 13.33-16.47 to the lowest quartile nurse staffing levels (p =.009 vs. p = .048 vs. p = .008). Although hospitals with higher NHPPD levels had lower readmissions within seven days (early readmissions), higher nurse staffing levels were associated with greater odds for readmissions within 30 days of the index hospital discharge when controlling for covariates of patient and hospital characteristics. The hypothesis was partially supported for the relationship between nurse staffing and early readmission. However, the hypothesis was not supported for the overall readmissions within 30-days associated with nurse staffing.

CHAPTER 5

DISCUSSION

Nurses are the mainstay of health care. Interest in the relationship between the structure of nursing care delivery (i.e., number of nurses staffed/adequacy) and patient outcomes is growing. Within this era of pay for performance programs created under the 2010 Affordable Care Act (ACA), attention has shifted to include emphasis on budget costs associated with nurse staffing productivity metrics to meet financial targets. Fueling the attention within the health care industry are financial penalties and lower reimbursements based upon patient outcomes under the ACA.

Changes in reimbursement models for payment on outcomes pose financial burdens previously not experienced and consequently have increased financial uncertainty for hospital leaders. Readmissions within 30 days of hospital discharge as a patient outcome, under the Hospital Readmission Reduction Program (HRRP), the Center for Medicare and Medicaid is required to reduce payments to acute care hospitals with excess readmission of targeted conditions (CMS, n.d.). Despite some reported success of the HRRP, hospitals may incur annual penalties of up to 3% of the base DRG that represent as few as one to three patient readmissions per CMS condition over a three-year performance period.

Without question, hospitals have a central role in reducing avoidable readmissions under provisions set forth in the HRRP. Some evidence suggests hospitals have made progress in reducing readmissions because of the HRRP (Zuckerman et al., 2016). The program remains controversial, but this program likely will continue to play a central role in the government's health care cost reduction efforts with increased linkage of reimbursements from volume to quality or value. Creating the efficiencies necessary to maximize results on outcomes measures under pay for performance programs such as the HRRP will have comprehensive effects on patient care in acute care hospitals. Thus, a better understanding of the relationship between nurse staffing levels (which affects hospital costs) and 30-day readmissions as a pay for performance program is needed and was the purpose of this study.

The Quality Health Outcomes Model was used as the theoretical foundation for this descriptive correlational study. A cross-sectional approach using secondary data from a cohort of 30 hospitals and 42,876 patient encounters during January 1, 2016 to December 31, 2016 was used. This study was designed to answer several questions about the association of acute care hospital nurse staffing on readmissions within 30 days of discharge, namely:

RQ1. What were the readmission rates within 30 days from hospital discharge for CMS-targeted conditions of interest and in total of combined targeted conditions?

RQ2. What was the length of time between patients' index hospital discharges and readmissions within 30 days for the CMS-targeted conditions of interest?

RQ3. What patient demographic characteristics (i.e., sex, race/ethnicity, age, and length of index hospitalization) were associated with readmissions within 30-days?

RQ4. What hospital characteristics (case mix index, size, geographic location, and Magnet® status) were associated with readmissions within 30 days?

Lastly, the primary focus of this study was to test the hypothesis that adult patients discharged from acute care hospitals with higher nurse staffing levels are less likely to have a readmission within 30 days, controlling for patient and hospital characteristics.

Findings and Recommendations

Patient and Hospital Characteristics

Analyses of patient and hospital characteristics revealed patient ages were distributed across age categories ranging from 18 years to older than 75 years, and female patients had a greater percentage of discharges (51.7%) than male patients. There were more Whites than Blacks, Hispanics, and Other among all CMS conditions and hospital sizes. The race/ethnicity variable of Hispanic was derived by Vizient, Inc. from the ethnicity variable in combination with the race variable. Hispanic included all persons in the U.S. who self-identify as Hispanic or Latino. This study included predominately White patients, although according to the 2010 U.S. Census, Latinos are the largest ethnic group, followed by African Americans that suggest that, at least Hispanics, are underrepresented in this data.

Most patients had an index hospital length of stay of one to three days across all CMS conditions and hospital sizes. Patients discharged following elective total hip and knee arthroplasty represented the largest group of patients in the study followed by CHF patients (the most common cause for both hospitalization and readmissions). The cohorts of AMI, pneumonia, and COPD included in the study had similar patient volumes in each diagnostic group.

The 30 hospitals ranged in size from less than 250 beds to over 750 beds. Most of hospitals were 500-749 beds with the Mid-Atlantic region having the greater number of hospitals among the six regions. There were more non-designated Magnet® hospitals than designated Magnet® hospitals included in the study that may offer some insight of the nurse work environment that reflects on patient outcomes. In consideration of the diversity and clinical complexity of patients, most hospitals reported a mid-point CMI of 1.5-1.99 with the smaller hospitals (≤ 250 beds) that typically have lower acuity patients a CMI of 1.0-1.49. Most of the hospitals with 500-749 beds had the highest CMI of 2.0 and over, likely representative of the sicker patients and/or psychosocial diversity. Among the 30 study hospitals the overall mean NHPPD was 12.14. The range from lower to higher NHPPD appeared consistent with the hospital size, i.e., the smaller hospitals had the lowest NHPPD mean of 11.10 and highest NHPPD mean of 13.04 was seen in the larger hospitals. A more detailed analysis of four research questions and hypothesis testing are discussed in the following sections.

Readmission Rates for CMS-targeted Conditions

Analysis for RQ1 of the readmission rates for the CMS-targeted conditions showed there was little variation across different hospital sizes, geographic regions, or over the four quarters of 2016. The overall hospital readmissions rate for all CMS conditions was 13.0% however, when excluding the elective hip and knee arthroplasties, the rate of readmission is 17.5%, less than the reported 20-25% of Medicare patients readmitted within 30 days (Jencks et al., 2009). Consistent with findings in research literature, the highest readmission rates were found in the chronic conditions of congestive heart failure and chronic obstructive pulmonary disease across all hospital sizes with no seasonal variation.

The readmission rate for AMI was 15.3%. More AMI patients were male, aged 55 and over, White, and had a length of stay of less than seven days. For pneumonia, the rate of readmission was 13.8% and slightly below the 17% reported in the literature. Pneumonia was similar to AMI and CHF conditions, more pneumonia patients were 55 to 74 years of age representing over 40% of the hospital discharges and generally had a length of stay of one to three days. Patients discharged with a diagnosis of CHF had a readmission rate of 20.5%; lower than the 25% CHF readmissions reported in the literature (Krumholz et al., 2009; McHugh & Ma, 2013; Saucedo et al., 2014). COPD patients had a rate of 17.8% which is slightly lower than the 20.5% reported by Jennings et al. (2015). Over 60% of the COPD patients were 55 to 74 years of age and were typically hospitalized for less than seven days.

Patients with elective hip and knee arthroplasty, generally considered a healthier population had the lowest readmission rates but with some variation, 2.8% in the smaller hospitals to 3.1-5.3% in larger hospitals. Findings for hip and knee arthroplasty readmission rates are well within the 1.8% and 8.9% reported in the literature and consistent to the Medicare population of a 5% readmission rate (Suter et al., 2014). In this study, nearly 80% of the hip and knee arthroplasty patients were White, 65% were age 55-74 years, nearly 40% were female, and 85% were in the hospital for one to three days.

Time from Index Hospital Discharge to Readmission

As a surrogate measure for readmission that may have been related to the patient's clinical status/readiness for discharge, RQ2 found the median interval from index hospital discharge to readmission for all conditions was 12 days. Overall, 34.7% of patients discharged with a diagnosis of one of the five CMS-targeted conditions were readmitted in seven days or less, and this pattern was similar for categories of age, race/ethnicity, and hospital size. Although there are differences across geographic regions and hospitals, including patient health status, community resources, and availability of primary care, patients returning to the hospital within seven days may be a focused target for improvement. Improved care coordination and post-discharge follow-up could have the greatest impact within the first few days of discharge to prevent these early readmissions.

Although elective hip and knee patients had lower readmission rates compared to other CMS-targeted conditions, 50% of those readmissions occurred within seven days. In contrast, 30% of both congestive heart failure and chronic obstructive pulmonary disease patients were readmitted within seven days. Similar patterns in interval to readmission were observed geographically, except for hospitals in the New England region where patients were admitted sooner. In relation to elective hip and knee procedures, nursing care has been shown to be associated with readmissions (Lasater & McHugh, 2016). As CMS moves from the fee-for-service through bundled programs for major joint replacement, hospitals should identify early readmissions as an area for improvement. Nurses have a crucial role in patient assessment for discharge readiness; preventing early readmissions could improve the patient experience and excess readmission rates that will translate to reimbursements under VBP programs as well as the new bundled payment programs.

Magnet® designation has been considered a proxy measure for hospitals with exceptional nurse practice environments and representative of important factors associated with hospital characteristics. This study found that Magnet® designated hospitals had slightly lower early readmission rates as measured by the interval between index hospital discharge and readmission but this trend was not statistically significant and disappeared by 8-14 days.

Higher NHPPD levels had significantly lower readmissions within seven days or less compared to lower NHPPD quartiles. This inverse NHPPD relationship on readmissions within seven days or less suggests there may be an important association of acute care hospital nurse staffing levels in reducing early readmissions. The nurse practice environment may represent the acute care hospital work setting characteristics that facilitate or constrain nursing practice and may contribute to reducing the multifactorial problem of readmissions within the 30-day window.

Association between Patients' Demographic Characteristics and Readmissions

Patient demographic characteristics are an important factor for consideration in outcomes research. Differences in population size, age of patients, and race/ethnicity affect the health care staffing and resources needed. Many minority groups are concentrated in specific geographic areas and each population group have socioeconomic issues, health needs, and access to care concerns. CMS-targeted conditions were included as a patient characteristic because these directly affect the patient. Consistent with the work of others, this study identified patient demographic characteristics of age, sex, race/ethnicity that were associated with the odds of a readmission (Joynt et al., 2011; Kangovi, et al., 2012; Lasater & McHugh, 2016; Ma et al., 2015; Martsolf et al., 2014; Polit & Beck, 2008; Retrum et al., 2013; Saucedo et al., 2014; Stone & Hoffman, 2010; Weiss, 2007).

RQ3 found there were significant associations between patient demographic characteristics (i.e., sex, race, age, and length of stay) and readmissions within 30 days of index hospital discharge. For instance, Blacks had significantly higher rates of readmission than Whites and men higher rates than women, although more women were hospitalized. Blacks were also 18% more likely to be readmitted compared to Whites suggesting racial disparities exist and that there is less social/community support and access to health care where needed. The increasing diversity in the U.S. adds to the nurse staffing and workload. These issues bring opportunities and challenges for health care leaders and the health care team to create and deliver culturally competent care services to meet the social, cultural, and linguistic needs of patients. Often nurse staffing does not factor in the extra time required when English is not the patient's primary language. In the absence of a culturally literate and diverse work environment, even experienced nurses may not recognize the socioeconomic or cultural strengths and weaknesses that factor into helping a patient to be successful in managing a chronic disease and prevent readmission.

The odds of readmission from the multilevel logistic regression did not vary by age; the bivariate analyses showed the youngest and oldest age patients had similar readmission rates (14.3%). Determinants of appropriate levels of care post discharge involve medical, functional, cultural, and social aspects of the patient's illness. Appropriate discharge planning considers the patient's acute and chronic medical conditions, potential for rehabilitation, and decision-making capacity affecting the discharge destination and readmission risk that are not measured in this study but may represent important dissimilarities of age.

The index hospital length of stay had significant differences between the five groups. Readmission rates grew higher as the length of stay increased. Severity of illness is generally associated with the length of time required for maximum recovery; however, the average length of stay has shortened dramatically over the last 20 years or more (Needleman et al., 2006; Southern & Arnsten, 2015). The upward trend of readmission rates may be associated with the length of stay and suggest these patients are sicker or have greater health care needs. A patient length of stay of 1-3 days had a readmission rate of 9.5% compared to 4-6 days of 17.2%, 7-10 days of 20.9%, 11-14 days of 21.2%, and 15 days and over at 20.4%. Consistent with the bivariate analysis, the multilevel logistic regression showed a patient stay of 4-6 days had 42% greater odds of readmission compared to a stay of 1-3 days and as the length of stay increased there was a nearly 50%-64% greater odds for being readmitted.

Significantly, the chronic medical conditions of AMI, pneumonia, CHF, and COPD compared to elective hip and knee arthroplasty patients had nearly three to four times greater odds of being readmitted. The costs associated with managing these high risk and high cost chronic medical conditions (patient characteristics) underscore a system of episodic care and the need for improved post-discharge care focused on managing their underlying needs.

Of course, the issues in discharges and readmissions are multi-faceted and purely hospital-based initiatives to improve discharge planning/care coordination to reduce chronic disease readmissions (that are reimbursed) are too narrowly focused and may fail to address the true root causes of these readmissions. Improved alignment between hospitals and outpatient/primary care reimbursements for care in support of disease management and care coordination programs at the community level is needed. Patient co-morbidities and socio-economic status such as education level and income level factor into the complexity of patient care needs but were not captured in the data and create a limitation to the study.

Association between Hospital Characteristics and Readmissions

RQ4 explored case mix index, size, geographic region, and Magnet®-designation that may be associated with 30-day readmissions. Differences were found among the various hospital characteristics, but the associated relationship of these factors to readmissions was not significant. The 30 study hospitals were geographically diverse and represented large and small hospitals.

Case mix index (CMI) has been widely used as a proxy measure of disease severity and to compare hospital variation such as readmissions. Analysis of the CMI confirmed significant differences in the three categories (1.0-1.49 vs. 1.5-1.99 vs. 2.0 and over) as expected but, further analysis of the association to 30-day readmissions was not significant. The index was developed for calculating hospital payment based upon coded DRGs abstracted from the medical record and may not be a reliable predictor at least for now, since in the absence of technology to analyze health record documentation, the CMI depends on human factors associated with accurate provider documentation and coder abstraction for DRG coding.

Hospital size did not appear to have a significant association with readmissions, i.e., those hospitals with 251-499 beds and 500-749 beds had higher readmission rates than those with 250 beds or less and those with 750 beds or more. Hospitals in the Southeastern and Western regions had slightly higher rates in overall readmissions but, from the multilevel logistic regression analysis, geographic regions were not associated with 30-day readmissions. In conjunction with findings from patient characteristics, this may suggest that the categories of size and geographic region have their own set of interrelated issues including nurse staffing levels. Researchers have reported there are many different reasons for variation in readmission rates across geographic regions and hospital sizes including patient health status, access to resources, patient to nurse ratios, clinical skill levels, and the tendencies to use the hospital as a primary source for care (Brown et al., 2014; Goodman et al., 2011 & 2013).

The nurse work environment attributable to staffing levels and adequate resources that are essential to attract and retain nurses are controllable by hospital leaders. As hospitals and health systems have been focused on cost control and restructuring of operations to achieve efficiencies, some cost savings have been realized at the expense of direct caregivers, including downsizing of the nursing workforce and changes in staffing mix. Currently, existing literature on the relationship of Magnet® status and hospital readmissions is limited. However, for this study Magnet® designation was used as a proxy measure of the nurse practice environments. There were significant differences between non-designated and designated Magnet® hospitals in the bivariate analysis; patients discharged from non-designated Magnet® hospitals had a slightly higher (0.8%) readmission rate. But further analysis did not find a significant association of Magnet® status on the odds of readmission within 30-days nor early readmissions within the interval between discharge and readmission.

Magnet®-designated hospitals tended to be larger, 12 of the 30 study hospitals were Magnet® (40%) and of these, three were hospitals with 251-499 beds, seven were hospitals that have 500-749 beds, and two that were 750 beds or more. This distribution seems to suggest the investment resources required to obtain Magnet® designation may be beyond the ability of smaller hospitals to commit.

Magnet® designation represents a higher level of recognition to hospital nursing services but requires significant investments and where some of the benefits are difficult to quantify (i.e.

reputation into revenue). Other challenges posed for smaller hospitals may be the availability of nurses with advanced education (BSN and above), nursing certifications, and ability to develop nurse driven research. It is also possible that unless nurses and their leaders have a full understanding of the Magnet® framework and the impact, they may be less likely to advocate for Magnet® or share its benefits with other colleagues. Another option may be to use the Practice Environment Scale of the Nursing Work Index (PES-NWI) as a gauge to measure the nurse practice environment. This study does not include PES-NWI data, however, using this survey tool, there is some evidence that shows better hospital work environments had lower odds of 30-day readmissions (Lasater & McHugh, 2016).

Association between Nursing Staffing Levels (NHPPD) and Readmissions

Investigation of whether patients discharged from acute care hospitals with higher nurse staffing levels were less likely to be readmitted within 30 days of their index hospital discharge was paradoxical. This study represented a convenience sample of 30 non-profit hospitals participating in the Vizient, Inc. collaborative and showed that the odds of patients being readmitted within 30 days of discharge was significantly greater in hospitals with higher nurse staffing levels (NHPPD) for the CMS-targeted conditions of acute myocardial infarction, pneumonia, congestive heart failure, chronic obstructive pulmonary disease, and elective total hip or knee arthroplasty. The finding of a significant relationship between the quantity of nurse staffing and readmissions is important considering growing interest in the relationship between nursing care delivery (number/adequacy of nurse staffing) and patient clinical outcomes.

Possible explanations may be that there were more complex patients requiring higher levels of nurse staffing, as evidenced by the short lengths of stay and the significantly greater odds of readmission within 30-days for patients discharged with a chronic disease diagnosis of AMI, CHF, and COPD compared to those patients with elective major joint replacements. Race/ethnicity, as a social determinate in the complexity of hospital care, also may offer some explanation into the higher staffing levels required. Blacks and Hispanics had significantly higher readmissions rates compared to Whites; and, Blacks had a longer length of stay for AMI while Hispanics had a longer length of stay for COPD.

There are also indirect levers on staffing that factor into possible explanations of higher nurse staffing levels on higher readmissions not measured in this study. Within the hospital there are generational differences among nurses, disparate technical skills (i.e., novice to expert, educational background, clinical area), epistemological dissimilarities, and time restraints to carry out the myriad of tasks and prioritization. Retention and recruitment efforts are constrained while younger nurses leave within two years of start thereby changing the work responsibilities for those that remain. More time is spent orienting and precepting, staff openings remain unfilled or are staffed with agency rather than a core nurse staff that build relationships that understand the strengths and weaknesses of the team.

There is limited research on the relationship of nurse staffing levels on readmissions within 30-days that may assist to inform on the business case for nursing. Based on the assumption that nurses who work in well-staffed hospitals have the time and the resources to provide better fundamental care to more effectively monitor for patient complications that may influence a length of stay and potential for readmission inspired this study. Findings were not consistent with those of other investigators and indicate that, after a critical threshold, nurse staffing may not reduce readmission rates. There was a small effect between the lowest and the highest NHPPD groups suggesting that nurse staffing and workload may be only a small part of the complex matrix of factors that contribute to 30-day readmissions. The results have provided support to directional associations and interesting clues of possible patient and hospital relationships between NHPPD and readmissions within 30 days that warrant deeper query.

Decades of research has shown hospital nurse staffing to be an integral element to patient care and associated with patient outcomes (Aiken et al., 2002, 2008, 2014; Clarke & Donaldson, 2008; Joynt & Jha, 2011; Kane, Shamliyan, Mueller, Duval & Wilt, 2007; Needleman et al., 2002; Shekelle, 2013; Unruh, 2008; Van Bogaert et al., 2014). For example, Aiken et al. (2002) found in hospitals with higher patient-to-nurse ratios, surgical patients experience higher risk-adjusted 30-day mortality and failure-to-rescue rates. Clarke and Donaldson (2008) identified nurse-sensitive indicators such as falls, pressure ulcers, catheter associated urinary tract infections, and central-line catheter associated infections with structure and processes of nursing care. Unruh (2008) found evidence that showed adequate staffing and balanced workloads were central to achieving good patient outcomes. Martsolf et al. (2014) determined adequate staffing were central to positive patient and financial outcomes. Other researchers have reported understaffing in the ICU increased the risk of serious infections for patients (Hugonnet et al., 2007; West et al., 2014). Another study reported better nurse staffing and work environments were significantly associated with 30-day readmissions for surgical patients (Ma & McHugh, 2015).

Quality Health Outcomes Model Theoretical Foundation

The organization of nurse staffing levels and workload are part of a complex matrix of relationships that contribute to hospital readmissions. The QHO model was useful to describe and organize a framework to evaluate relationships among the organizational structure of nurse staffing (hospital NHPPD) and hospital outcomes (patient readmissions within 30-days of CMS-targeted conditions) by adding a multi-level dimension to broadly evaluate four constructs: health care policy (ACA and HRRP), client (patient characteristics), system (hospital characteristics and NHPPD), and outcomes (readmissions within 30-days of index discharge). The QHO model served as a useful guide to index the interrelationships interacting simultaneously that function within the clinical, social, and organizational outcomes considered important for health care outcomes and nursing research. The QHO model was refined to include the construct of health policy with the constructs of system and outcomes and acknowledged the intervention construct (not tested in this study).

Multiple system attributes were examined to better understand the nurse staffing role on patient readmissions within 30 days from the index hospital discharge as a measure of hospital quality under the HRRP. Nurse staffing (NHPPD), the primary predictor of interest, had a symbiotic relationship with the hospital through work environments (Magnet®), geographical regions and case mix index, and patient characteristics of age, sex, race/ethnicity, and length of stay that influenced readmissions within 30 days. The HRRP under the ACA health policy had an underlying influence on each construct: hospitals to prevent unnecessary readmissions within 30 days on five CMS-targeted conditions; nurse staffing as an important determinant to the quality of patient care; and patient characteristics representative of socioeconomic factors, cultural diversity, and racial disparities.

This study had important limitations, several that have been discussed in chapter three and throughout sections in this chapter. The source of the data is an administrative database and NHPPD were not delineated by level of nurse specialization or hospital units (i.e., not differentiated by ICU versus non-ICU). For example, the nurse hours may represent hours of Licensed Practical Nurse (LPN) or Certified Nurse Aide (CNA) and RN and the dilutional effect of all nursing units measured at the hospital level given that there are different staffing models for ICU and non-ICU. The presence of RN case management/discharge planners, educational preparedness, overall experience level of the hospital nursing staff, and the presence of highly skilled/advanced practice support providers in the hospital cohort may have confounded the influence of NHPPD on readmissions and is not identified in the database.

Next, patient discharge destination is not considered in this study and may represent important dissimilarities as suggested in the absence of differences found in the data odds of readmission by age. There are 25 different CMS discharge destination codes ranging from discharged to home/self-care, home health services, skilled nursing care, and long-term care to name a few. The destination hints to the dissimilarities of patient needs, complexity, severity of illness, and risk for readmission that was not captured in the data. For example, long-term care facilities typically care for older aged adults that may experience a higher incidence of CHF and/or pneumonia (i.e., likelihood of readmission) than those patients discharged to home/self-care. Hospitals also may be geographically located to more long-term care facilities that may result in those hospitals having a higher burden of readmissions.

Further, patient comorbidity conditions are not included in this study although these conditions generally are associated with worse health outcomes, more complex clinical management, and greater health care resources (Martsolf et al., 2014; Needleman et al., 2006). There have been policy changes representing a shift in the cost of care burden and that affect the clinician's decision to admit a patient as an inpatient or for an observation stay that is not captured in the data. These changes may arbitrarily have a positive or negative effect on actual readmissions. Lastly, the data are not risk adjusted for diagnosis or patient sociodemographic factors that have long been considered a contributing factor of readmissions and the inability of hospitals to influence post-hospital care (Kahn et al., 2015; McHugh et al., 2013).

Although the future of the ACA is now uncertain, the new proposals as part of the repeal and replace legislation (i.e., American Health Care Act, Better Care Reconciliation Act, Obamacare Reconciliation Repeal Act) did not rescind provisions of the HRRP, and value-based payment continues to have bipartisan support (Thompson et al., 2017). Reducing readmissions involves multifaceted interventions including adequate nurse staffing as an important strategy to promote optimal care and financial outcomes resulting from pay-for-performance programs.

As hospitals leaders consider how to prevent avoidable readmissions to lower their readmission rates, preventing early readmissions may be a potential strategy since the hospital may have more influence over the associated patient readiness for discharge and discharge planning processes that nurses have a key role in providing. Lower early readmission rates in hospitals with higher NHPPD (quartiles) and in Magnet®-designated hospitals provided an intriguing level of curiosity to the potential linkage of NHPPD to readmissions that warrants consideration for further research.

Pay-for-performance as part of value based purchasing borne out of health care reform, potentially leaves financial resources at risk if hospitals are unsuccessful in delivering on various prescribed outcomes. The need for consistent delineation of RN, LPN, & CNA hours fields for reporting NHPPD to improve understanding of the effect of nursing on these outcomes and facilitate thoughtful decisions on design of appropriate and adequate staffing models are essential. CMS and other organizations that complete/publish hospital rating, ranking, and public reporting to demonstrate the quality of care provided and patient outcomes are increasingly including NHPPD as a metric to measure and distinguish a hospital apart from other hospitals. These types of transparent public reports of positive outcomes (e.g., the best place to receive care), as a marketing strategy and for hospitals to be included in employer and payer health care networks, will depend on effective organizational structures that includes adequate nurse staffing levels and processes of care to protect patients from harm.

Moreover, a future study of NHPPD using patient turnover at the hospital and nursing unit-level on readmissions within 30 days should be considered. The average daily census - without consideration of total patient turnover on nurse staffing - inhibits the ability to understand important factors associated with patient care and outcomes relevant to reimbursements and safety. Patient turnover (considered as the sum of patients admitted, discharged, and transferred from a nursing unit during a shift) also must be taken into consideration when determining the nursing effect on readmissions within 30 days of hospital discharge. The average daily census used to determine nurse staffing levels does not reflect the number of patient admissions and discharges that occurred on the nursing unit or hospital. These processes are recognized as time/labor intensive for nurses and thus may have a nursing effect on readmissions.

In conclusion, other researchers have provided compelling evidence on the implications of nurse staffing adequacy on patient outcomes including readmissions that are significant to health care leaders, patients and their families and important to informing practice and health care policy (Aiken, 2002, 2010; Cho et al., 2003; Kane et al., 2007; Ma et al., 2015; Needleman et al., 2002; Weiss et al., 2011). While expected findings predicting a significant relationship between higher NHPPD and lower readmissions within 30 days for five CMS-targeted conditions were not realized, the study did contribute to the body of nursing knowledge. Further research in understanding these complex interactions between NHPPD and the complexity of care delivery on patient outcomes such as readmissions will be important to build on existing knowledge and inform strategy about the value of investments in nurse staffing to benefit patients and reimbursement for care.

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APPENDIX A.

TARGETED MEDICAL READMISSION CONDITIONS

Inclusion Criteria	Rationale
1. All patients age 18 years or older.	Hospital claims are available for all patients and payers allowing for broader generalization of results.
2. Discharged from a nonprofit adult acute care hospital alive participating in the Vizient consortium.	Only those patients discharged alive from a hospital participating in the Vizient consortium are eligible for readmission.
3. Primary diagnosis of pneumonia, acute myocardial infarction, heart failure, or chronic obstructive pulmonary disease.	Primary diagnoses of pneumonia, acute myocardial infarction, heart failure, or chronic obstructive pulmonary disease are specified as part of the HRRP under the ACA and of interest in this study.
4. Pneumonia cohort ICD-9 codes: 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483.0, 483.1, 483.8, 485, 486, 487.0, 488.11	Included in the HRRP and submitted to Vizient by participating hospitals into the clinical database.
5. Acute myocardial infarction cohort ICD-9 codes: 410.00, 410.01, 410.10, 410.11, 410.20, 410.21, 410.30, 410.31, 410.40, 410.41, 410.50, 410.51, 410.60, 410.61, 410.70, 410.71, 410.80, 410.81, 410.90, 410.91.	Included in the HRRP and submitted to Vizient by participating hospitals into the clinical database.
6. Heart failure cohort ICD-9 codes: 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9	Included in the HRRP and submitted to Vizient by participating hospitals into the clinical database.
7. Chronic obstructive pulmonary disease cohort ICD-9 codes: 491.21, 491.22, 491.8, 491.9, 492.8, 493.20, 493.21, 493.22, 496, 518.81, 518.82, 518.84, 799.1	Included in the HRRP and submitted to Vizient by participating hospitals into the clinical database.

APPENDIX B.

TARGETED SURGICAL READMISSION CONDITIONS

Inclusion Criteria	Rationale
1. All patients 18 years or older.	Hospital claims are available for all patients and payers allowing for broader generalization of results.
2. Discharged from a nonprofit adult acute care hospital alive participating in the Vizient consortium.	Only those patients discharged alive from a hospital participating in the Vizient consortium are eligible for readmission.
3. Have a qualifying elective primary total hip arthroplasty (THA) or total knee arthroplasty (TKA) procedure, without any of the following:	Elective primary THA/TKA is a procedure of interest in this study.
a. Femur, hip, or pelvic fractures coded in the principal or secondary discharge diagnoses fields of the index admission.	Procedures to correct an orthopedic fracture are considered non-elective. Patients with orthopedic fracture tend to have higher mortality, complication, and readmission rates
b. Partial hip arthroplasty procedures with concurrent THA/TKA	Partial hip arthroplasty is primarily indicated for hip fractures.
c. Revision procedures with a concurrent THA/TKA	Few hospitals perform THA/TKA revision procedures and patients are associated with higher mortality, complications, and readmission rates.
d. Resurfacing procedures with a concurrent THA/TKA	Resurfacing procedures are distinctly different than THA/TKA and are primarily indicated for younger, healthier patients.
e. Mechanical complications of the pelvis, sacrum, coccyx, lower limbs, or bone/bone marrow or disseminated malignant neoplasm coded in the principal discharge diagnosis field	A mechanical complication was likely present on admission and may require more technically complex procedures to correct. Patients with malignant neoplasms undergoing a THA/TKA are likely not elective and the patients are more likely to have a readmission.
4. THA/TKA cohorts ICD-9 codes: 81.51, 81.54	Included in the HRRP and submitted to Vizient by participating hospitals into the clinical database.

APPENDIX C.

NURSE STAFFING LITERATURE REVIEW

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
To determine whether nurse-staffing in CA hospitals, where state-mandated minimum NTP ratios are in effect, differs from 2 states w/o legislation & whether those differences are associated with nurse & patient outcomes.	Aiken et al. (2010)	IV	Descriptive	Primary survey data from 22,336 hospital staff nurses in CA, PA, & NJ in 2006 and state hospital DC databases.
Addresses the economics of nursing from a broad perspective that considers how both national policies such as hospital prospective pmt. & managerial decisions within institutions impact the outcomes of nurses & patients.	Aiken (2008)	I	Systematic literature review	Nurse shortage, hospital cost containment initiatives; nursing & cost offsets.
Analyze the net effects of nurse practice environments on nurse & patient outcomes after accounting for nurse staffing & education.	Aiken et al. (2008)	IV	Retrospective descriptive	Data for 10,184 nurses & 232,342 surgical patients in 168 PA hospitals were analyzed. Care environments measuring the practice environment scales of the Nursing Work Index. Outcomes: nurse job satisfaction, burnout, intent to leave, & reports of quality of care, as well as mortality & failure to rescue in patients.
Assess the association between PTN ratio & patient mortality, FTR among surgical patients & factors r/t nurse retention.	Aiken et al. (2002)	IV	Cross-sectional	4/1/1998 to 11/30/1999 data from nurse surveys & patient DC in PA
To examine the effects of nurse staffing on adverse events, morbidity, mortality, & medical costs.	Cho et al. (2003)	IV	Retrospective descriptive	Using 2 existing databases; study sample of 232 acute care CA hospitals & 124,204 patients in 20 surgical diagnostic related groups.

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Examined job-related burnout in RNs to determine whether it accounts, in full or in part, for the relationship between nurse staffing & patient infections acquired during hospitalization.	Cimiotti et al. (2012)	IV	Retrospective descriptive	2006 Nurse survey data to the PA Health Care Cost Containment Council report on hospital infections & the American Hospital Assoc. Annual Survey.
Application of FTR to nursing on patient outcomes of care.	Clark & Aiken (2003)	n/a	Case study	24-7 surveillance on outcomes.
The economic value of incremental changes in nurse staffing that may result in improved quality of patient care.	Dall et al. (2009)	IV	Retrospective descriptive	Literature review & 2005 hospital DC data from NIS data linked with AHA Annual Survey for hospital characteristics, mortality risk, LOS, & cost per DC associated with nursing sensitive outcomes.
Determine the effect of nurse staffing on total profit margin in more competitive and less competitive hospital markets.	Everhart et al. (2013)	IV	Non-experimental descriptive correlational	2008 Florida statewide nursing survey with the AHA annual survey & area resource file.
Compare conceptual definitions & frameworks associated with unfinished care, missed care, implicitly rationed care & care left undone.	Jones et al. 2015	I	Systematic review	CINAHL & MEDLINE for 1828 studies narrowed to 54 studies retained.
Association between RN staffing & nurse-sensitive patient outcomes	Kane et al. (2007)	I	Systematic review & meta-analysis of observational studies	28 studies with different designs.
To define, operationalize, measure, and evaluate the nurse surveillance capacity of hospitals.	Kutney-Lee et al. (2009)	IV	Secondary analysis of data derived from a 50% random sample survey of PA RNs conducted in 1999	Used existing RN survey data to create a Hospital Nurse Surveillance Capacity Profile for each study hospital. Variables: staffing, education, clinical expertise, practice environment.
Determine if CA minimum nurse staffing legislation created changes	Mark et al. (2013)	1 or II	Difference-in-difference approach	AHRQ Patient Safety Indicators to measure

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
in acuity-adjusted nurse staffing & quality of care.			to compare changes in staffing & quality. Experimental design using observational data (consider as possible quasi-experimental)	quality, AHA Annual survey, CA office of Statewide Health Planning & Development & the Hospital Cost Report Information System with the HCUP databases from 2000-2006.
Assess the effect of nurse staffing on quality of care & inpatient care costs.	Martsolf et al. (2014)	IV	Longitudinal hospital fixed effect model	2008-2011 HCUP database from CA, NV, & MD to assess nurse staffing levels & skill mix on patient care costs, LOS, & adverse events.
Examining nurse staffing ratios for CA hospitals to compare staffing in similar hospitals across the U.S. Goal was to assess the effect of CA policy on changes in hospital staffing & skill mix.	McHugh et al. (2011)	I	Pre-post experimental design. Approximating a randomized experiment in the CA & comparison hospitals	RN staffing, nursing skill mix, & other control variables in all adult nonfederal, acute care hospitals in the U.S. during 1997-2008. Data for hospital characteristics was from the AHA Annual survey for 1997-2008.
Examined the relation between the levels of staffing by nurses in hospitals & the rates of adverse outcomes among patients, using administrative data from a large multistate sample of hospitals.	Needleman et al. (2002)	IV	Retrospective descriptive	1997 admin data for 799 hospitals in 11 states (covering 5,075,969 DC of medical patients & 1,104,659 DC of surgical patients) to examine the relation between the amount of care provided by nurses at the hospital & patient outcomes.
Examine data to help hospitals & policymakers consider both the business & social cases for investing in nurse staffing by estimating the costs of increasing staffing & cost savings resulting from avoided deaths, reduced LOS, & decreased adverse patient outcomes associated w/higher nurse staffing levels.	Needleman et al. (2006)	IV	Retrospective descriptive	Data from 799 nonfederal acute care general hospitals in 11 states. DC abstracts & nurse staffing data were obtained from the states; data on hospital size, location, teaching status, from the AHA annual survey; and cost-to-

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
				charge ratios from Medicare cost reports.
Hospital-level administrative data rather than a cross-sectional design to examine the association of nurse staffing & patient outcomes.	Needleman et al. (2011)	IV	Retrospective descriptive correlational	2003-2006 data from the medical center electronic data system. 43 hospital units for IP mortality, RN staffing/unit-shift, patient turnover, other unity & shift measures, patient-level measures.
Describe & critique the body of knowledge relating costs to nursing practice & propose an effective method of analyzing the costs of patient care so that cost sensitivity to nursing can be studied.	Pappas (2007)	VI	Prospective descriptive-single center	Multiple variables including financial, cost per case & LOS. A convenience sample of 2 acute care, not-for-profit hospitals serving multi age & cultural communities was selected to participate. Data was examined monthly continuously during 6/2004-7/2006.
Describe the methodology for nursing leaders to determine the cost of adverse events & effective levels of nurse staffing.	Pappas (2008)	IV	Nonexperimental descriptive	3 DRGs were the focus of the analysis. 5 adverse events were analyzed along with the costs.
One of 15 demonstration program in the Medicare Coordinated Care Demonstration with nurse case managers. WU care managers were assigned to 20% of patients deemed the most complex based on conditions, unmet needs, caregiver resources, & recent history of acute care services used.	Peikes et al. (2012)	I	Randomized experimental with an intent-to-treat design	All adult FFS Medicare beneficiaries living in the St. Louis metropolitan area.
Examination of improved outcomes associated with lower PTN ratios on cost-savings to hospitals.	Rothberg et al. (2005)	VII	Cost-effective analysis	Cost-effectiveness in dollar per life saved of various PTN ratios using national cost estimates combined with patient mortality data from 1 large study & LOS data from another.

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Examined the evidence on the effects of interventions aimed at increasing nurse-patient ratios on patient illness & death	.Shekelle (2013)	I	Systematic review	28 studies, of which 17 were cohort studies, 7 were cross-sectional studies, & 4 were case-control studies (no experimental studies were identified)
Determine the impact of implementing the NHPPD staffing method on 14 nursing-sensitive outcomes and LOS	Twigg et al. (2011)	IV	Interrupted time series using retrospective design	Analysis of patient and staffing administrative data from 3 adult tertiary hospitals in metropolitan Perth over a 4-yr period.
Assess the impact of hospital nurse staffing levels on given patient, nurse, and financial outcomes.	Unruh (2008)	I	Systematic literature review	5 databases covering articles published from 1980 through 2006.
Assess the relative validity of patient turnover adjustments & the difference in nurse staffing using measures that adjust for patient turnover & severity versus those that do not.	Unruh & Fottler (2006)	IV	Retrospective descriptive	Numbers of RNs adjusted patient days of care (APDC), LOS, & patient severity information from acute care general hospitals in PA 1994-2001, obtained from the PA Dept. of Health, the AHA, & the Atlas MediQual system.
To investigate the impact of nurse practice environment factors, nurse work characteristics, & burnout on nurse reported job outcomes, quality of care, & patient adverse events variables at the nursing unit level.	Van Bogaert et al. (2014)	VI	Cross-sectional survey	1108 nurses assigned to 96 nursing units composed of various validated instruments measuring nurse practice environment factors, nurse work characteristics, burnout, nurse reported job outcomes, quality of care, & patient adverse events.
Nurse staffing & patient assessment of readiness for DC & post DC utilization.	Weiss et al. (2011)	IV	Retrospective cross-sectional drawn from a larger study.	162 pairs of nurse & medical surgical patients from 13 units

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
				& 4 Midwest hospitals.

Key: +ARCC model level of evidence (Fineout-Overholt, Melnyk, & Schultz, 2005)

APPENDIX D.

READMISSION LITERATURE REVIEW

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Examine the proportion of Medicare expenditures attributable to repeated readmissions (*readmission defined prior to ACA P4P programs)	Anderson & Steinberg (1984)	IV	Retrospective descriptive	Random sample of 2 databases. Claims data for all Medicare beneficiaries from 1974-1977. AHA Annual Survey for hospital characteristics. Analyzed data for readmission within 365 days, 60, 30, or 5 days of DC.
Examine clinical performance, patient satisfaction & readmission rates to see if higher patient satisfaction w/DC process are more likely to lower readmissions.	Boulding et al. (2011)	IV	Retrospective descriptive cohort	2005-2008 Hospital Compare & AHA databases for HF, AMI & PN patients.
Examined the association of hospital patterns of medical care with rates of 30-day readmissions.	Brown et al. (2014)	IV	Retrospective cohort, descriptive correlational	Medicare patients hospitalized with AMI between 2008-2009 in 1088 hospitals.
Examine the association between cost of care & processes to 30-day mortality rates, readmission rates & 6 month IP cost of care.	Chen et al. (2010)	IV	Retrospective cross-sectional cohort descriptive	3 databases, 2004-2006 MEDPAR & IPPS Impact file & Hospital Quality Alliance for CHF & PN patients.
Examined whether the spectrum of readmission dx & median time to readmission varied by categorization of performance & variation for the HF, PN & AMI.	Dharmarajan et al. (2013)	IV	Retrospective descriptive cohort	2007-2009 Medicare claims data for HF, PN & AMI patients.
Regional variation rates of HF & PN readmissions @ 30-60-90 days compared to population based rates of patients with coexisting conditions.	Epstein et al. (2011)	IV	Retrospective cross-sectional descriptive using 2 data sets	2008 MEDPAR of HF & PN patients in 306 hospital referral regions including 4432 hospitals & 234,477 DC patients.
Explain variances associated with 30-day PN readmission rates.	Flanagan & Stamp (2016)	IV	Retrospective descriptive cohort	2011 AHA Annual survey for hospital characteristics; 2009-2011 AHRQ Quality

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Understand the relationship between nurse staffing & 30-day readmission ratios for HF patients in the top US adult cardiology & heart surgery hospitals.	Giuliano et al. (2016)	IV	Retrospective observational descriptive, correlational	Outcomes Measures, 2011-2012 HCAHPS & CMS databases for PN patients. Matching CMS Hospital Compare database with the 2013 US News & World Report for best hospitals for cardiology & heart surgery; 2012 AHA annual survey for nurse staffing.
Identify risk predictors for 30-day readmission of COPD patients.	Glaser & El-Haddad (2015)	VI	Retrospective descriptive cohort	2015 HRRP Hospital Specific Report in a single center for COPD patients.
Describe interventions aimed at reducing COPD readmissions.	Hansen et al. (2011)	I	Systematic review	43 articles of 3 domains & 12 activities r/t COPD patients readmitted.
Explore individual perceptions of life purpose, health related quality of life & hospital readmissions among patients with HF.	Hodges (2009)	VI	Descriptive, correlational mixed method using a qualitative & quantitative concurrent triangulation	Setting of San Antonio, TX 41 participants aged 60 years & older with HF.
Nurse discharge advocate intervention to improve hospital readmission rates.	Jack et al. (2009)	III	RCT	Single center study of 749 patients.
Examine the disparate factors that influence rehospitalization focused on 3 questions: What is the frequency of unplanned & planned rehospitalizations within 30 days after DC? How long does the elevated risk of rehospitalization persist? What is the frequency of follow-up of outpatient visits w/a physician after a patient's DC from the hospital?	Jencks et al. (2009)	IV	Retrospective Descriptive correlational design	10/1/2003-12/31/2004 MEDPAR claims data from 4926 hospitals to describe the patterns of rehospitalization, relationship of demographic characteristics on rehospitalization & hospital characteristics on rehospitalization.
Examine the predischarge bundle completion in reducing COPD readmission rates.	Jennings et al. (2015)	III	RCT	Single center RCT, pre-DC bundle & COPD patients.

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Examine DC planning of CHF patients & readmission rates.	Jha et al. (2009)	IV	Retrospective descriptive cohort	2008 Hospital Quality Alliance & AHA Annual Survey of 2 DC planning measures.
Surgical readmissions & transitional care interventions	Jones et al. (2016)	I	Systematic Review	PubMed search including 1995-2015; 3527 abstracts identified, 3 RCTs & & observational studies met inclusion criteria.
Determine whether black patients have higher odds of readmission than white patients & whether disparities are r/t site of care received.	Joynt et al. (2011)	IV	Retrospective descriptive cohort	2006-2008 MEDPAR data of AMI, CHF & PN patients. Race & site of care
Examine hospital characteristics of 30-day readmission rates & likelihood of performing in the worst quartile nationally.	Joynt & Jha (2011)	IV	Retrospective cross-sectional cohort descriptive	2006-2007 MEDPAR & AHA survey for hospital characteristics of HF patients.
Examine hospital performance for FY2015 payment under 3 P4P programs (HRRP, HAC, & VBP)	Kahn et al. (2015)	IV	Retrospective descriptive	2015 CMS Impact file combined with multiple data sources to classify hospitals.
Explore patient perspectives on readmissions.	Kangovi et al. (2012)	VI	Cross-sectional 36 item survey of patients readmitted	1084 patients readmitted.
Examine the rates & potential risk factors for 28 day readmission following a fracture of the hip in a high-volume tertiary center.	Khan et al. (2012)	VI	Retrospective descriptive cohort	Single center of 498 patients using the ortho registry database.
Examine relationship between 30-day mortality rates & readmission rates among patients with AMI, HF, & PN.	Krumholtz et al. (2013)	IV	Retrospective cross-sectional descriptive	2005-2008 Medicare claims files to identify AMI, HF, & PN admissions, readmissions & mortality.
Quantify procedural rate & revision burden of total hip & knee readmissions.	Kurtz et al. (2005)	IV	Retrospective descriptive cohort	1990-2002 National hospital discharge survey of arthroplasty patients.
Examine the effect of nurse staffing & the work environment on 10- and 30-day unplanned readmissions for Medicare patients	Lasater & McHugh (2016)	IV	Retrospective cross-sectional, descriptive from 3 data sets	2006 MEDPAR, multi-state nursing care & patient safety study survey, & the AHA annual survey (nurse staffing). 112,017 Medicare beneficiaries DC following

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
following elective THA & TKA.				elective THA & TKA in 495 acute care hospitals in 4 states.
Describe the development, validation & results of a risk-standardized readmission rate for PN patients in the federal quality measurement & efficiency initiative.	Lindenauer et al. (2011)	IV	Retrospective cohort	Medicare beneficiaries w/PN dx from 4675 U.S. hospitals claims data.
Relationships between hospital nursing work environments, nurse staffing & nurse education on surgical patient readmissions.	Ma et al. (2015)	IV	Retrospective cross-sectional descriptive using 3 data sets.	2006-2007 RN survey from CA, FL, NJ & PA. AHA survey & MEDPAR of patients with general, ortho, vascular surg. 528 hospitals & 220,914 patients.
Nurse work environments, nurse staffing levels & nurse education on readmissions.	McHugh & Ma (2013)	IV	Retrospective cross-sectional drawn from 3 data sets.	2005-2006 data from CA, PA, & NJ. Measures from cross-sectional RN survey; AHA hospital survey; State admissions & DC of patients 65 yrs. & older w/AMI, PN & HF.
RN staffing levels & hospital performance in HRRP for HF, PN, & AMI.	McHugh et al. (2013)	IV	Retrospective cross-sectional from 2 data sets.	2013 HRRP Supplemental Data File for hospital penalties on HF, PN & AMI readmissions; staffing ratio of RN hours per patient day from 2009 AHA survey.
Characterize reasons, timing & factors associated with surgical readmissions including hip & knee	Merkow et al. (2015)	IV	Retrospective descriptive cohort	ACS NSQIP registry of surgical patients between 1/1/2012-12/31/2012.
Determine if nurse care coordination efforts reduced readmission rates.	Peikes et al. (2009)	I	Systematic review	15 RCTs of care coordination programs done by nurses.
Report results of RCT evaluating interventions to reduce COPD readmissions	Prieto-Centurion et al. (2010)	I	Systematic review of RCT interventions to reduce COPD rehospitalization	5 studies from 913 titles published between 1/1966 & 6/2013 met criteria.
Identify the incidence, risk factors, & etiology of 30-day readmissions after total joint arthroplasty.	Pugely et al. (2013)	IV	Retrospective descriptive cohort	ACS NSQIP registry of patients with elective TKA & THA during 1/1/2011-12/31/2011.

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Investigate patient perspectives for their HF readmissions.	Retrum et al. (2013)	VI	Qualitative descriptive cohort	Recruited adult patients from an academic & a community hospital dx w/HF & readmitted with 180 days.
To describe models designed to compare hospital rates of readmission or to predict patients' risk of readmission, as well as to identify studies evaluating patient characteristics associated with hospital readmission, all among patients admitted with HF.	Ross et al. (2008)	I	Systematic review	Relevant studies published between 1/1/1950 and 11/19/2007 in English on readmission after HF hospitalization among adult patients 117 articles met inclusion criteria.
Examine the rates & reasons for readmiss after primary TJA & characteristics of predictors for patients most at risk.	Saucedo et al. (2014)	VI	Retrospective descriptive cohort – single center	Enterprise data warehouse for all THA & TKA readmissions during 1/1/2006-12/31/2010.
Compare THA 90-day readmission rates to characterize the cause & risk factors associated w/readmission.	Schairer et al. (2014)	VI	Retrospective descriptive cohort – single center	Administrative claims between 2005-2011 of THA patients.
Examine TKA 90-day readmission rates to characterize the cause & risk factors associated w/readmissions.	Schairer et al. (2014)	VI	Retrospective descriptive cohort – single center	Administrative claims between 2005-2011 of 1408 TKA patients.
Examine COPD readmissions w/use of post-acute care, skilled nursing facilities to reduce readmission rates.	Shah et al. (2015)	IV	Retrospective descriptive cohort	2006-2010 of 7 states using Medicare claims data for COPD patients readmitted.
Understanding the differential impact of HCAP & CAP on readmission & determine if variability in case mix between the 2 might alter the aggregate readmission rate.	Shorr et al. (2013)	VI	Retrospective descriptive cohort – single center	977 PN patients. Administrative data (unclear of data source).
AMI patients admitted to high volume hospitals & evaluate the effects of a patient's "exposure" to a hospital's cardiac mgmt style & associated outcomes & variations across hospitals.	Stukel et al. (2010)	IV	Longitudinal cohort of 77 centers	2000-2006 AMI patients in 5 Canadian health associated databases.

Description / Focus of Study	Authors	+ Level of Evidence	Study Design	Data & Study Variables
Examine the judgments from multiple practicing physicians using standardized implicit review methods to determine whether urgent readmissions were potentially avoidable.	van Walraven et al. (2011)	IV	Prospective descriptive	Multicenter. Urgent readmissions occurring within 6 months of DC of 4812 patients that included 649 readmitted.
Examine rates & reasons for THA readmissions	Vorhies et al. (2011)	IV	Retrospective descriptive cohort	2002-2008 Medicare Patient Safety Monitoring System database for THA patients.
Predictors & outcomes of readiness for DC in acute medical-surgical patients.	Weiss et al. (2007)	IV	Correlational prospective longitudinal	1 Midwestern tertiary center. 147 med-surgical patients. Patient & hospital characteristics with quality of DC teaching scale & care coordination scale.
Assessing predictors of COPD readmissions	Yu et al. (2015)	IV	Retrospective descriptive cohort	2009-2012 Truven Health claims data for COPD patients.

Key: +ARCC model level of evidence (Fineout-Overholt, Melnyk, & Schultz, 2005)

APPENDIX E.

Human Subjects Determination

Instructions: Submit this signed form, along with the study protocol and any data use agreement or supporting information as applicable. Materials can be scanned and emailed to humansubjects@kumc.edu or faxed to (913) 588-5771.

Principal Investigator: Cynthia Teel, PhD, RN, FAAN; Shin Hye Park, PhD, RN;

Student Investigator: Virginia Boos, MSN, RN, Doctoral Student

Department: School of Nursing

Phone: 913-588-1697

Today's Date: 7/26/2016

STUDY TITLE: THE RELATIONSHIP OF NURSE STAFFING IN ACUTE CARE HOSPITALS ON 30-DAY READMISSIONS IN AN ERA OF PAY FOR PERFORMANCE.

Briefly state the purpose of the proposed research.

To determine if there is a relationship between hospital-based nurse staffing (RN & non-RN Hours per Patient Day for ICU and non-ICU) and the rate of hospital readmissions within 30 days of discharge for Centers for Medicare & Medicaid Services targeted conditions of pneumonia, heart failure, acute myocardial infarction, chronic obstructive pulmonary disease, and elective total hip arthroplasty/total knee arthroplasty. Understanding how hospital nursing impacts patient outcomes can help inform hospital leaders, researchers, and policy makers about the value of additional investments and the consequences of reduced investments in nurse staffing.

Is there funding for this research?

- ☐ Yes. If yes, specify:
- ☒ No

What materials (data, specimens, images, etc.) will be used for the research?

2014 administrative claims data from Vizient (formerly known as University Health System Consortium (UHC)) located in the Operational Data Base and the Clinical Data Base.

Are the patients who provided the research materials living or deceased?

☐ All living

☐ All deceased

☐ Both living and deceased

☒ Unknown. Explain Administrative data

Do all the research materials exist as of today's date?

☒ Yes

☐ No. If no, answer the questions below in terms of how the materials *will be* collected.

How were the materials collected or how will they be collected?

Vizient collects hospital administrative data and hospital patient discharge data from 5200 nonprofit academic medical centers and integrated hospital systems. Data is voluntarily submitted by Vizient affiliated hospitals. For this study, data from 120 hospitals that submitted both operational and clinical data sets in the year 2014 will be used.

For what purpose were the materials collected or for what purpose will they be collected?

Strategic research, advocacy, and benchmarking for affiliated hospitals.

Who is (was) collecting the materials?

Vizient collects data from membership hospitals and will distribute de-identified 2014 data to Student Investigator Virginia Boos.

If the materials currently exist, how are they being stored?

The data will be transmitted via a secure file in a password protected website. Upon receipt the data will be stored in a KUMC secure folder in the School of Nursing Q Drive.

Did (or will) the original collection take place under an IRB-approved protocol?

☐ No, the original collection is/was for clinical purposes only.

☐ Yes, KUMC HSC #

☐ Yes, IRB approval at another institution. *Enclose the IRB approval and approved consent form*.

☒ Unknown. Explain: **Vizient data and analytics is available for strategic research, advocacy, and benchmarking for affiliated hospitals.**

Which individual identifiers or demographics will be associated with the materials when they are viewed by you or released to you for your research? *(If none, so indicate)*

Names	☐	Ages over 89 years	☐	Street address, city, county, precinct or zip code	☐
Initials	☐	Identifying # or code #*	☐	Health plan # or other account #	☐
Phone	☐	Other unique descriptor	☐	Vehicle identifier, serial #, license plate, etc.	☐
Fax	☐	Facial photos/images	☐	Biometric identifiers (finger/voice/retina)	☐
E-mail	☐	Social Security Number	☐	Device identifiers or serial numbers	☐
URL	☐	Certificate/License #s	☐	Date of birth, date of death, admit/discharge date	☒
IP address	☐	Medical Record #s	☐	Other date related to the person (except year only)	☐
None of the identifiers listed above will be included with the materials used for the study					☐

*For projects in which a code number is the only identifier received by the KUMC researcher:

What are the elements of the code?

Who holds the key to the code (i.e., the "master list")?

For projects using coded data, submit documentation from the holder of the key, confirming that the key which links data to individual identities will not be released to the KUMC researcher.

Is this study being done to support an IND or IDE submission? (*IND's and IDE's are special permissions from FDA to use investigational drugs or investigational devices in a research study.)*

☐ Yes

☒ No

Will any of your data be held for inspection by the U.S. Food and Drug Administration or submitted to the U.S. Food and Drug Administration for any purpose?

☐ Yes

☒ No

Will the research involve the use of human specimens to test an in-vitro diagnostic device?

☐ Yes

☒ No

____ ________________

Principal Investigator Signature Date

APPENDIX F.

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VIZIENT DATA REQUEST APPLICATION

Section A: Individual & Organization Requestor Information:

Requestors Name & Title: Ginny Boos RN MSN – KU School of Nursing PhD Candidate Cindy Teel PhD RN FAAN – Co-Principle Investigator Shin Hye Park PhD RN – Co-Principle Investigator
Requestors Employing Organization & Department: Saint Luke's Health System Quality Department (Ginny Boos) University of Kansas School of Nursing (Cindy Teel & Shin Hye Park)
Requestors Telephone Number: 913-317-7494 (work) 913-461-9325 (cell)
Requestors E-Mail Address: Ginny Boos: vboos@saint-lukes.org & vboos@kumc.edu Cindy Teel: cteel@kumc.edu Shin Hye Park: spark@kumc.edu
Sponsoring Organization (Database Licensee) if different from requestor's employing organization: University of Kansas Medical Center School of Nursing
Sponsoring Organization's Officer (VP or higher) who will approve the project: Katherine Howell, Senior Executive Chief Nursing Officer
Sponsoring Organization **contact** who is authorized to receive data uploads from VIZIENT: Ginny Boos
Contact's E-Mail Address: vboos@saint-lukes.org
Date Requested: Date Desired:
File Format : □ SAS □ ACCII □ Excel □ Word □ Text

<u>Section B: Reason For Data Request</u>:

☐ Internal performance improvement project

☐ Research interest within organization

☐ Research interest among multiple organizations

X Other (Please Describe)__Dissertation__________________________________ vizient

Section C: Description of Project:

1. Description/title of the project:
   THE RELATIONSHIP OF NURSE STAFFING IN ACUTE CARE HOSPITALS ON 30-DAY READMISSIONS IN AN ERA OF PAY FOR PERFORMANCE

2. Purpose and significance of the project:
   The purpose of this descriptive correlational study is to determine if there is a relationship between the independent variables of hospital-based nurse staffing (RN and non-RN productive HPPD of direct care providers in the ICU and Non-ICU) and the dependent variable rate of hospital readmission within 30 days of discharge for CMS-targeted conditions (pneumonia, acute myocardial infarction, heart failure, chronic obstructive pulmonary disease, and elective total hip & knee arthroplasty).

   Under the ACA readmissions reductions have been singled out as an important way to improve both the quality of care and lower health care spending. There is little empirical evidence describing the relationship between nurse staffing and 30-day readmissions. Understanding how hospital nursing impacts patient outcomes can help inform hospital leaders about the value of additional investments and the consequences of reduced investments in nurse staffing.

3. Proposed Study Period: 1/1/2014 – 12/31/2014

4. Proposed Study Cohort:
   Adult patients readmitted within 30 days from discharge of index hospitalization with a primary or secondary diagnosis of pneumonia, acute myocardial infarction, heart failure, chronic obstructive pulmonary disease, and elective total hip & knee arthroplasty.

- Inclusions:

- Exclusions:

5. Personnel – Please list all persons (e.g., staff, subcontractors, affiliated agencies) who will have access to the confidential data.
   Ginny Boos, Cindy Teel, Shin Hye Park, Jianghua He

6. How do you anticipate VIZIENT staff participating in this study?
   (VIZIENT will provide a description of any VIZIENT fees to support the project.)

X Provide data

☐ Provide study design expertise

☐ Support analysis

☐ Review draft manuscript

☐ Other (Please
describe____)

7. IRB approval received ☐Yes ☐No ☐Not required
   <u>If YES:</u> Please include the current documentation of the IRB approval for the project.

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8. Attach letter of support from an officer of the sponsoring organization (VIZIENT member licensee).

9. If applicable, list source(s) of funding and duration of funding for the project.

<u>Section D:</u>

<u>VIZIENT DATA USE POLICIES & DATA DESTRUCTION:</u>

X I/We have read and understand VIZIENT policy governing the public use of data and information in research

X I/We have read and understand VIZIENT policy governing public use of VIZIENT data and information for promotional use

X I/We have read and understand VIZIENT Data Ownership policy

X I/We have read and understand VIZIENT Publication Rights policy

X I/We agree to only use the data requested for the sole purposes of the project outlined above.

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REQUESTOR CHECKLIST:

☐ Data request application

☐ IRB Documentation if required

☐ Letter of support from sponsoring organization

☐ Funding documentation

APPENDIX G.

SUMMARY OF PATIENT CHARACTERISTICS

Variable	Mean (*SD*)	Frequency	Percent
Age Range in Years	66.5 (14.5)		
18-44		2,944	6.9
45-54		5,236	12.2
55-64		11,054	25.8
65-74		11,407	26.6
≥ 75		12,235	28.5
Sex			
Male		20,714	48.3
Female		22,162	51.7
Race/Ethnicity			
Black		8,667	20.2
Hispanic		1,724	4.0
Other		2,558	6.0
White		29,927	69.8
Length of Stay (Days)			
1-3		26,260	61.2
4-6		10,257	23.9
7-10		4,124	9.6
11-14		1,267	3.0
15 & Over		968	2.3

Note: N=42876

APPENDIX H.

Patient Characteristics by Hospital Size (*N*=30)

	Total		Hospital Size by Staffed Beds							
			≤ 250 *n*= 6		**251-499 *n* = 6**		**500-749 *n* = 15**		**≥ 750 *n* = 3**	
	N	%	*n*	%	*n*	%	*n*	%	*n*	%
Age Range in Years										
18-44	2,944	6.9	319	4.9	512	5.5	1,499	7.7	614	8.0
45-54	5,236	12.2	714	11.0	927	10.0	2,619	13.5	976	12.7
55-64	11,054	25.8	1,595	24.6	1,985	21.5	5,373	27.6	2,101	27.3
65-74	11,407	26.6	1,709	26.4	2,358	25.5	5,104	26.2	2,236	29.1
≥ 75	12,235	28.5	2,142	33.1	3,462	37.5	4,868	25.0	1,763	22.9
Sex										
Male	20,714	48.3	2,922	45.1	4,365	47.2	9,735	50.0	3,692	48.0
Female	22,162	51.7	3,557	54.9	4,879	52.8	9,728	50.0	3,998	52.0
Race Ethnicity										
Black	8,667	20.2	858	13.2	1,687	18.2	4,238	21.8	1,884	24.5
Hispanic	1,724	4.0	87	1.3	647	7.0	836	4.3	154	2.0
Other	2,558	6.0	112	1.7	1,071	11.6	1,069	5.5	306	4.0
White	29,926	69.8	5,422	83.7	5,839	63.2	13,320	68.4	5,346	69.5
Index Hospital Length of Stay										
(Range in Days)	26,260	61.2	4,168	64.3	4,928	53.3	12,114	62.2	5,050	65.7
1-3	10,257	23.9	1,541	23.8	2,607	28.2	4,447	22.8	1,662	21.6
4-6	4,124	9.6	549	8.5	1,137	12.3	1,803	9.3	635	8.3
7-10	1,267	3.0	140	2.2	333	3.6	605	3.1	189	2.5
11-14	968	2.3	81	1.3	239	2.6	494	2.5	154	2.0
≥ 15										

APPENDIX I.

Patient Characteristics by CMS-targeted Conditions

	CMS Conditions											
	Total *N*=42,876		**AMI** *N*=5,164		**PN** *N*=6,167		**CHF** *N*=11,592		**COPD** *N*=5,294		**Hip & Knee** *N*=14,659	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Age Range (Years)												
18-44	2,944	6.9	274	5.3	828	13.4	831	7.2	276	5.2	735	5.0
45-54	5,236	12.2	627	12.1	730	11.8	1,338	11.5	616	13.1	1,925	13.1
55-64	11,054	25.8	1,114	21.6	1,306	21.2	2,401	20.7	1,639	31.3	4,594	31.3
65-74	11,407	26.6	1,299	25.2	1,258	20.4	2,582	22.3	1,406	33.2	4,862	33.2
≥ 75	12,235	28.5	1,850	15.1	2,045	33.2	4,440	38.3	1,357	20.8	2,543	17.3
Sex												
Male	20,714	48.3	2,900	14.0	3,026	14.6	6,127	29.6	2,282	11.0	6,379	30.8
Female	22,162	51.7	2,264	10.2	3,141	14.2	5,465	24.7	3,012	13.6	8,280	37.4
Race/Ethnicity												
Black	8,667	20.2	975	18.9	1,211	19.6	3,531	30.5	1,257	23.7	1,693	11.5
Hispanic	1,724	4.0	219	4.2	296	4.8	508	4.4	131	2.5	570	3.9
Other	2,558	6.0	309	6.0	437	7.1	685	5.9	269	5.1	858	5.9
White	29,927	69.8	3,661	70.9	4,223	68.5	6,868	59.2	3,637	68.7	11,538	78.7
Index Hospital Length of Stay (Range in Days)												
1-3	26,260	61.2	2,863	55.4	3,180	51.6	4,785	41.3	2,874	54.3	12,558	85.7
4-6	10,257	23.9	1,292	25.0	1,832	29.7	3,786	32.7	1,608	30.4	1,739	11.9
7-10	4,124	9.6	583	11.3	794	12.9	1,908	16.5	566	10.7	273	1.9
11-14	1,267	3.0	207	4.0	223	3.6	633	5.5	151	2.9	53	0.4
≥ 15	969	2.3	219	4.2	138	2.2	480	4.1	95	1.8	36	0.2

Note: Abbreviations: AMI, acute myocardial infarction; PN, pneumonia; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; Hip & Knee, Hip & Knee Total Arthroplasty.

APPENDIX J.

Geographic Regions Mapped by State Defined by Vizient

Region / States	Region / States
Mid-Atlantic	**New England**
Delaware	Connecticut
District of Columbia	Maine
Maryland	Massachusetts
New Jersey	New Hampshire
New York	Ontario
Pennsylvania	Rhode Island
Virginia	Vermont
West Virginia	
Mid-Continent	**Southeastern**
Arkansas	Alabama
Colorado	Florida
Kansas	Georgia
Missouri	Kentucky
Montana	Louisiana
Nebraska	Mississippi
New Mexico	North Carolina
North Dakota	South Carolina
Oklahoma	Tennessee
South Dakota	
Texas	
Wyoming	
Midwestern	**Western**
Illinois	Alaska
Indiana	Arizona
Iowa	California
Michigan	Hawaii
Minnesota	Idaho
Ohio	Nevada
Wisconsin	Oregon
	Utah
	Washington

APPENDIX K.

Hospital-level Summary of Study Hospital Characteristics (*N*=30)

	≤ 250 Beds *n*=6		**251-499 Beds *n*=6**		**500-749 Beds *n*=15**		**≥ 750 Beds *n*=3**		**Total *N*=30**	
NHPPD Mean (*SD*)	11.10 (1.90)		11.14 (2.69)		12.61 (1.38)		13.04 (1.31)		12.14 (1.98)	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***N***	***%***
Geographic Region										
Mid-Atlantic	1	16.7	1	16.7	4	26.7	1	33.3	7	23.3
Mid-Continent	3	50.0	3	50.0	0	0	0	0	6	20.0
Midwestern	1	16.7	0	0	3	20.0	0	0	4	13.3
New England	0	0	1	16.7	1	6.6	0	0	2	7.0
Southeastern	1	16.7	0	0	3	20.0	2	66.7	6	20.0
Western	0	0	1	16.7	4	26.7	0	0	5	17.0
Magnet Designated										
No	6	100.0	3	50.0	8	53.3	1	33.3	18	60.0
Yes	0	0	3	50.0	7	46.7	2	66.7	12	40.0
CMI Range										
1.0-1.49	5	83.3	0	0	0	0	0	0	5	17.0
1.5-1.99	1	16.7	3	50.0	4	26.7	0	0	8	27.0
≥ 2.0	0	0	3	50.0	11	73.3	3	100.0	17	57.0

APPENDIX L.

Distribution of Hospital Characteristics by Patient Discharges (*N*=42,876)

Variable	Frequency of Patient Discharge Encounters	Percent
Case Mix Index (range)		
1.0-1.49	5,975	13.9
1.5-1.99	10,774	25.1
2.0 & over	26,127	60.9
Hospital Size (staffed beds)		
≤ 250	6,479	15.1
251-499	9,244	21.6
500-749	19,463	45.4
≥ 750	7,690	17.9
Geographic Region		
Mid-Atlantic	12,807	29.9
Mid-Continent	8,020	18.7
Midwestern	3,397	7.9
New England	3,736	8.7
Southeastern	9,104	21.2
Western	5,812	13.6
Magnet® Designation		
Not Designated	23,835	55.6
Designated	19,041	44.4

APPENDIX M.

Summary of Readmission Rates for CMS Conditions by Quarters in 2016

	Readmission			
CMS Condition	**No**	**Yes**	**%**	**χ^2**
AMI				
1st Quarter	1,119	168	13.1	
2nd Quarter	1,161	239	17.1	8.91*
3rd Quarter	994	189	16.0	
4th Quarter	1,100	194	15.0	
Total	4,374	790	15.3	
Pneumonia				
1st Quarter	1,880	275	12.8	
2nd Quarter	1,439	235	14.0	4.22
3rd Quarter	1,013	161	13.7	
4th Quarter	986	178	15.3	
Total	5,318	849	13.8	
CHF				
1st Quarter	2,638	658	20.0	
2nd Quarter	2,473	676	21.5	5.72
3rd Quarter	2,034	546	21.2	
4th Quarter	2,074	493	19.2	
Total	9,219	2373	20.5	
COPD				
1st Quarter	1,176	261	18.2	
2nd Quarter	1,176	241	17.0	0.853
3rd Quarter	922	201	17.9	
4th Quarter	1,078	239	18.1	
Total	4,352	942	17.8	
Hip & Knee Arthroplasty				
1st Quarter	4,035	162	3.9	
2nd Quarter	3,627	155	4.1	4.12
3rd Quarter	3,231	161	4.7	
4th Quarter	3,142	146	4.4	
Total	14,035	624	4.3	

Note: *p = .03. N = 42,876. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

APPENDIX N.

Summary of Readmission Rates for Hospital Size by CMS Conditions

	Readmission			
Hospital Size	**No**	**Yes**	**%**	χ^2
≤ 250 Beds				255.27*
AMI	711	106	13.0	
Pneumonia	868	115	11.7	
CHF	1,169	257	18.0	
COPD	831	150	15.3	
Hip & Knee Arthroplasty	2,208	64	2.8	
251-499 Beds				296.16*
AMI	836	163	16.3	
Pneumonia	1,484	219	12.9	
CHF	1,994	522	20.7	
COPD	1,067	246	18.7	
Hip & Knee Arthroplasty	2,569	144	5.3	
500-749 Beds				714.38*
AMI	2,183	414	15.9	
Pneumonia	2,114	366	14.8	
CHF	4,601	1218	20.9	
COPD	1,740	368	17.5	
Hip & Knee Arthroplasty	6,142	317	4.9	
≥ 750 Beds				438.98*
AMI	644	107	14.2	
Pneumonia	852	149	14.9	
CHF	1,455	376	20.5	
COPD	714	178	20.0	
Hip & Knee Arthroplasty	3,116	99	3.1	

Note: **p* < .001. *N*=42,876. Abbreviations: AMI, acute myocardial infarction; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

APPENDIX O.

Summary of Patient Interval Days from Discharge to Readmission

Variable	Interval Range in Days 1-3	4-7	8-14	15-21	22-30	χ^2
CMS Conditions						
Acute Myocardial Infarction	17.6	20.6	25.8	16.8	19.1	
Pneumonia	18.1	18.7	25.4	20.6	17.1	196.23***
Congestive Heart Failure	13.2	17.9	26.4	21.8	20.7	
COPD	15.2	13.7	25.4	23.6	22.2	
Hip & Knee Arthroplasty	34.8	15.4	19.9	13.3	16.7	
Race/Ethnicity						
Black	14.9	18.0	25.6	20.4	21.1	
Hispanic	14.8	16.0	25.5	23.9	19.8	15.86
Other	21.9	17.0	23.0	19.3	18.9	
White	18.2	17.3	25.3	20.0	19.2	
Age (Range in Years)						
18-44	14.8	18.3	25.0	23.3	18.6	
45-54	13.6	17.1	27.8	19.5	22.0	22.88
55-64	17.1	18.3	23.9	20.1	20.6	
65-74	17.7	17.3	26.2	20.0	18.8	
75 & over	19.4	16.7	24.7	20.1	19.1	
Length of Stay (Range in Days)						
1-3	17.8	17.7	26.1	19.5	19.0	
4-6	16.5	16.8	24.6	21.3	20.8	17.67
7-10	17.1	17.3	25.1	20.4	20.2	
11-14	17.5	18.2	24.2	24.5	15.6	
15 & Over	19.8	19.3	23.9	13.7	23.4	
NHPPD (Quartiles)						
6.41-11.18	19.3	18.2	24.0	19.5	19.0	
11.26-12.33	17.4	18.4	23.9	20.2	20.2	21.95*
12.35-13.32	17.1	14.6	26.7	20.2	21.4	
13.33-16.47	15.8	18.3	26.5	21.1	18.3	
Hospital Size by Staffed Beds						
≤ 250	17.6	17.3	27.9	20.1	17.1	
251-499	19.2	18.8	23.6	19.0	19.4	21.68**
500-749	17.2	16.8	25.6	19.8	20.6	
750 & over	14.9	17.2	24.8	23.7	19.6	
Geographic Region						
Mid-Atlantic	19.7	15.2	24.9	21.6	18.6	
Mid-Continent	15.6	19.0	26.3	20.4	18.6	74.31***
Midwestern	16.1	15.2	25.2	20.1	23.4	
New England	26.5	16.8	23.0	14.1	19.7	
Southeastern	13.3	19.4	25.7	21.9	19.7	
Western	16.3	18.3	25.5	18.5	21.4	
Case Mix Index (CMI)						
1.0-1.49	17.7	17.6	27.7	20.1	16.9	
1.5-1.99	22.6	16.4	22.8	18.6	19.6	48.93***
2.0 & over	14.9	17.8	25.9	21.1	20.3	
Magnet® Designation						
Non-designated	17.6	18.1	25.3	20.1	18.8	5.67
Designated	17.0	16.4	25.2	20.5	20.9	

Note. $^*p = .038$; $^{**}p = .041$; $^{***}p < .001$. $N = 5{,}578$. Abbreviations: COPD, chronic obstructive pulmonary disease; NHPPD, nursing hours per patient day.

APPENDIX P.

Multilevel Logistic Regression of Hospital Characteristics on Readmissions

Variable	***t***	***OR (95% CI)***	***p* value**
Case Mix Index (Range)			
1.0-1.49 (Ref.)			
1.5-1.99	-0.87	0.80 (0.48, 1.32)	.383
2.0 & Over	-1.04	0.76 (0.45, 1.28)	.298
Hospital Size (Staffed Beds)			
≤ 250 (Ref.)			
251-499	1.82	1.59 (0.96, 2.64)	.069
500-749	1.36	1.38 (0.87, 2.18)	.173
≥ 750	0.95	1.29 (0.76, 2.18)	.343
Geographic Regions			
Mid Atlantic (Ref.)			
Mid-Continent	-1.51	0.83 (0.65, 1.06)	.132
Midwestern	1.16	1.16 (0.90, 1.48)	.247
New England	0.72	1.10 (0.85, 1.44)	.472
Southeastern	0.58	1.06 (0.88, 1.27)	.561
Western	0.17	1.02 (0.83, 1.26)	.865
Magnet® Designation			
Non-Designated	1.59	1.13 (0.97, 1.31)	.111
Designated (Ref.)			

Note: Analysis controlled for nurse staffing quartiles and patient characteristics (i.e., age, sex, race/ethnicity, length of stay, and CMS conditions).
Information criterion: *AIC* = 224,049.00; *BIC* = 224,056.67
N=42,876.