ENHANCING PATIENT SAFETY: EXAMINING FACTORS ASSOCIATED WITH RECOVERY OF MEDICAL ERRORS BY MEDICAL-SURGICAL NURSES

by

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A Dissertation
Submitted to the
Graduate Faculty
of
George Mason University
in Partial Fulfillment of
The Requirements for the Degree
of
Doctor of Philosophy
Nursing

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DEDICATION

This is dedicated to my loving and patient husband Steve, who accompanied me on this journey. To my mother (1928 to 2015) who never let me lose sight of my goal. To both my mother-in-law and sister-in-law who cared for my family while I pursued my studies. To my daughter who was a superb cheerleader. And to the rest of my family, friends, and colleagues who made sure I completed the journey.

ACKNOWLEDGEMENTS

Pursuing a doctoral degree has been a lifelong goal of mine and one that I enjoyed every step of the way. However, it was only with the support of colleagues such as Beth Ulrich that I not only began but completed this journey. Thank you for the endless hours of mentoring!

I especially want to thank Dr. Barbara Hatcher for her support, guidance, and patience as I worked my way through this dissertation. She was always there when I had questions or needed encouragement. I also want to thank Drs. Milligan and Gerber for serving on my committee, providing insight and keeping me on the right path. Drs. Mallinson and Dr. Richards, I am grateful to you both for teaching me how to write an abstract and mentoring me through several Southern Nursing Research Society meetings. Debby Kermer’s tutorials on Qualtrics were amazing! Finally, am grateful to Amber Trickey, biostatistician, who provided consultation throughout this study.

Next, I want to thank my colleagues at the American Nurses Association who offered both advice and support throughout the entire process. They are a great team to have at your side.

Special thanks to Loressa Cole and Ellen Linkenhoker for supporting me in this study. Also, I am grateful to Dr. Patricia Dykes for allowing me to use the instrument she and her colleagues developed.

Finally, must express my gratitude for my classmates Carla and Sandy who reviewed my papers, answered my questions, offered advice, and kept me focused. You are true friends and colleagues!

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ABSTRACT

ENHANCING PATIENT SAFETY: EXAMINING FACTORS ASSOCIATED WITH RECOVERY OF MEDICAL ERRORS BY MEDICAL-SURGICAL NURSES

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George Mason University, 2015

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This thesis examined the relationships between nurse characteristics, organizational factors, and recovery of medical errors among medical-surgical nurses in hospitals. Research has focused on error causation rather than error recovery that consists of identifying, interrupting, and correcting errors before patient harm occurs. Greater understanding of factors that influence error recovery can aid in the development of strategies to reduce negative patient outcomes. A descriptive cross-sectional, correlational study was conducted using a convenience sample of 184 medical-surgical nurses across the country. Each medical-surgical nurse recovered, on average, 22 medical errors in a three-month period. Regression analysis using a negative binomial model revealed that three factors were significantly associated with medical error recovery; education (p = .001), expertise (p = .003), and hospital size (p = .016). Findings suggest that expert medical-surgical nurses with advanced education were better able to recover

medical errors. Factors such as education and expertise should be considered when staffing units to reduce negative consequences and improve patient safety.

CHAPTER ONE: INTRODUCTION

Making health care safer is a national mandate, yet little progress has been made in reducing the medical error rate in the past fifteen years (Aranaz-Andrés et al., 2011; Landrigan et al., 2010). Errors are actions that fail to meet their desired outcome. Although, errors regularly occur in health care, they can be recovered to mitigate patient harm. The recovery process consists of identifying, interrupting, and correcting medical errors. Safety conscious organizations must anticipate that errors will occur and incorporate error recovery strategies into their patient safety efforts (Habraken & van der Schaaf 2010; Helmreich 2000; Reason 1990). Although nurses' role in medical error recovery is gaining recognition, little is known about the individual characteristics that distinguish nurses who are most effective at recovering errors or the organizational factors that influence error recovery. Further examination of nurses' role in the recovery process would provide important insight into positive recovery factors. The purpose of this study was to explore individual and organizational factors that influence nurses' role in recovering medical errors.

Background

The widespread and persistent issue of medical errors has challenged the fundamental mission of our health care system. The landmark report, *To Err is Human*, published by the Institute of Medicine (IOM) (2000) first alerted health care providers and consumers of the alarming rate of medical errors. The report noted that between 44,000 and 98,000 individuals die each year as a result of medical errors, yet nearly half of all errors are preventable (Leape, 1997). National efforts to reduce medical errors quickly followed with organizations such as the Institute for Healthcare Improvement (IHI) and Joint Commission creating guidelines to prevent medication errors, eliminate hospital-acquired infections, and reduce wrong site surgeries (Pham et al., 2012). In spite of these focused national efforts, there has been limited success in reducing the number of medical errors (MacDonald, 2013). Today, medical errors occurring in over 33% of hospital admissions (De Meester, Van Bogaert, Clarke, & Bossaert, 2013). More than a decade of concentrated efforts to make health care safer has resulted in little progress toward establishing a culture of safety. As such, patients continue to experience preventable harm (Chassin & Loeb, 2013; James, 2013; Sari et al., 2010).

Errors are defined as actions that fail to meet their desired outcome, particularly when the individual had prior intention and possibility to reach the intended outcome (Blavier, Rouy, Nyssen, & De Keyser, 2005; Reason, 1990). It is through this notion of intention that the human aspect arises. In health care, the terms human error and medical error are frequently used interchangeably. Definitions of medical errors provided by the IOM, the World Health Organization (WHO), and the Agency for Health Care Research and Quality (AHRQ) are subtly different, yet they remain similar in their focus on two distinct components (a) actions that are not completed as planned; and (b) using the wrong plan to address an issue. In this study, errors are defined as the "failure of planned actions to be completed as intended or when the wrong plan is used to achieve an aim" (Institute of Medicine [IOM], 2000, p. 28).

Medical errors have a significant impact on the health and safety of patients, providers, organizations, and the public. Patients experiencing a medical error may not only be physically harmed, but they may also experience mental and emotional consequences. De Smedt and colleagues (2011) found that patients experiencing an adverse drug event believe it to be a serious event that not only impacted their well-being but also caused worry. Health care providers may experience frustration with the health care delivery system, fear of disciplinary action, and emotional distress. It is estimated that as few as 5% of errors are reported (Cook, Woods, & Miller, 1998). The overall financial impact of medical errors on the nation's health care costs is rising. A retrospective study of medical claims found that the financial cost of preventable medical errors in 2008 was $17 million (Jill et al., 2011). Today estimates are closer to $37 million (De Meester et al., 2013). Finally, the prevalence of errors results in decreased public confidence in a health care system meant to heal (Kalra, 2004; Pham et al., 2012). This lack of confidence is demonstrated by one in four consumers reporting they did not feel safe being admitted to a hospital (Evans, Berry, Smith, & Esterman, 2006).

Research investigating the nature and impact of medical errors within the health care system began in earnest in the 1990s. Initially, individuals were blamed as the source of medical errors (Carayon, 2007; Henriksen, Dayton, Keyes, & Carayon, 2008; Reason, 1990). More recently, the paradigm has shifted from one of "bad people" to focus on “bad systems” (Dickson & Flynn, 2012). The human factors framework views systems as a set of interdependent components working together toward a specific goal (Henriksen et al., 2008). In health care environments, many interdependent components including people, teams, technology, structure, culture, and information come together to create a complex system (Morag et al., 2012). Layers of subsystems add further complexity. For example, a nursing unit is comprised of many interdependent components striving to provide safe patient care. The nursing unit is a component of a larger hospital system that, in turn, is a component of the national health care system. Increased complexity increases the likelihood of errors. The systems approach assumes that increasing complexity results in unpredictable behaviors leading to errors (Chassin & Loeb, 2013; Jacobs, Soares, & Karwowski, 2012; Kopec, Kabir, Reinharth, Rothschild, & Castiglione, 2003).

Great emphasis has been placed on error prevention over the past few decades. Health care adopted lessons from other high-risk, complex industries such as aviation to reduce medical errors. In the late 1960s, the aviation industry noted that human error accounted for 70% of aviation accidents (Helmreich, 2000). Safety measures to prevent errors such as checklists and crew resource management were put into place (Lewis, Vaithianathan, Hockey, Hirst, & Bagian, 2011). When it was noted that the level of safety in aviation had not improved as expected, the industry expanded its focus to include not only error prevention but also error recovery by training pilots to detect and correct errors (Amalberti, 1998).

Errors cannot be eliminated from any system as they are embedded in human intelligence (Gilbert, Amalberti, Laroche, & Paries, 2007; Reason, 1990). The most safety conscious health care organizations must expect errors will occur (Habraken & van der Schaaf, 2010; Helmreich, 2000; Reason, 1990). Empirical evidence indicates that individuals identify 70% of their errors and 40% of errors made by others (Amalberti, 1998; Reason, 1990). Error recovery is emerging as an integral strategy in patient safety efforts.

Adequate recovery processes can prevent patient harm. The error recovery process is a sequential three-step process consisting of identifying, interrupting, and correcting errors (Henneman & Gawlinski, 2004; Jambon, 1997; Kontogiannis & Malakis, 2009; van der Schaaf & Kanse, 2000). More importantly, the recovery process is the differentiating factor between patient harm and a near miss. Recognizing medical errors and intervening to prevent patient harm; therefore, is a vital component of creating and sustaining a safety culture (Blavier et al., 2005; Jambon, 1997; van der Schaaf & Kanse, 2000). A safety culture is established when the structures, processes, and employee perceptions prioritize safety as an important organizational factor (Carayon, 2007; Henriksen et al., 2008; Reason, 1990). Creating a culture of safety and reducing the negative consequences of human error in health care organizations requires not only preventing errors but also successful error recovery (Blavier et al., 2005). Examining and improving recovery processes is a vital patient safety strategy that must be a focus of all health care organizations.

As frontline providers, nurses play an indispensable role in keeping patients safe (Institute of Medicine, [IOM] 2004). Given their knowledge and intimate relationship with patients, and their role at the bedside, nurses are well positioned to identify, interrupt, and correct medical errors (Henneman & Gawlinski 2004, Yang et al., 2012). To date, a small body of research has provided evidence that nurses working in specialty areas successfully recover medical errors and prevent or mitigate patient harm. Dykes, Rothschild, and Hurley (2010) estimated that critical care nurses recovered, on average, one error per week. Operating room nurses recovered an average of 11 errors per procedure (Yang et al., 2012). Although medical-surgical nurses are the largest nursing specialty providing care in hospitals, there have been no studies determining the frequency of errors recovered by this population or examination of factors facilitating the recovery process among this population.

Greater understanding of nurses' role in error recovery and individual and organizational factors that influence the recovery process can foster the development of effective strategies to detect and correct medical errors thus enabling organizations to reduce negative outcomes. Additionally, greater knowledge related to error recovery processes can inform educational strategies to enhance error recovery skills among nurses.

Purpose of the Study

The phenomenon of medical error recovery as a critical defense against medical errors is relatively new, and the mechanisms involved in the recovery process are not well known (Blavier et al., 2005; Henneman & Gawlinski, 2004). The primary purpose of the study was to examine relationships between individual nurse characteristics, organizational factors and recovered medical errors among medical-surgical nurses working in hospitals. A secondary purpose was to identify individual and organizational factors predicting recovery of medical errors by medical-surgical nurses in hospitals.

Research Questions

The research questions addressed in this study were as follows.

For medical-surgical nurses in hospitals:

1. What is the relationship between individual nurse characteristics and recovered medical errors (i.e. age, education, experience, expertise, certification, and personality)?

2. What is the relationship between organizational factors and recovered medical errors (i.e. Magnet designation and workload)?

3. What nurse characteristics or organizational factors predict recovery of medical errors?

Conceptual Framework

The phenomenon of error first emerged in the early 1900s with studies exploring the human role in accidents. The theory that humans were the cause of errors persisted until the late 1980s when human factors experts and cognitive psychologists explored the interdependencies between people and physical, cognitive, and organizational factors (Armitage, 2009). Errors arise from system weaknesses and are more likely to occur in complex systems. The complexity of the health care system with multiple interdependencies between individuals, teams, technology, structure, culture and information makes it especially prone to errors (Morag et al., 2012).

There are several ways to classify errors. The most prominent classification system is that of Reason's (1990) cognitive based stages that include: skill-based, rule-based and knowledge-based errors. Rule-based errors deviate from intentions and occur when attention momentarily lapses. These errors can be recovered using cues. Knowledge-based errors result when the plan is inadequate to achieve the expected outcome and recovery requires higher level cognitive processes. As errors cannot be eliminated, it is important to reduce their consequences.

Building on human factors engineering theories, the Eindhoven Model of Incident Causation acknowledges that errors are caused by technical, organizational, or human failures (van der Schaaf, 1992). When dangerous situations develop, automatic system defenses can prevent negative consequences. In the case of high-risk situations, however, system defenses are not always sufficient to resolve the incident. Human operators must engage in the recovery process by identifying, interrupting, and correcting errors to prevent negative consequences. In this sense, humans are considered a critical system element and a key component of error recovery (Reason, 2008).

The recovery process consists of both planned and unplanned steps (van der Schaaf & Kanse, 2000). Planned recovery steps involve the activation of defenses that are built into the system to avoid patient harm. Examples of these defenses are standardized procedures and protocols that individuals are expected to follow. Unplanned recovery steps are more ad hoc in nature and reflect the clinical reasoning and creative problem-solving abilities of the human operator. Since these steps are not standardized, they are not known to everyone and do not become embedded in organizational learning.

Henneman and colleagues (2010) modified the Eindhoven Model of Incident Causation and the three-stage recovery process for the health care setting. Studies of critical care and emergency nurses found that nurses identify errors through their knowledge of the patient and the environment. Using surveillance techniques and analysis, nurses collect data in an ongoing and systematic process. They interrupt errors that either they or others committed using inference and evaluation techniques such as asking for clarification and offering assistance. Inductive skills including verbal interruption are used when the potential for an adverse event is high. Finally, nurses use deductive skills such as confirming the plan of care, referring to the standards of practice, and involving others when correcting errors. An error is referred to as a “near miss” when it is successfully recovered, and patient harm is averted. When errors are not successfully recovered, adverse events and potentially catastrophic consequences may occur.

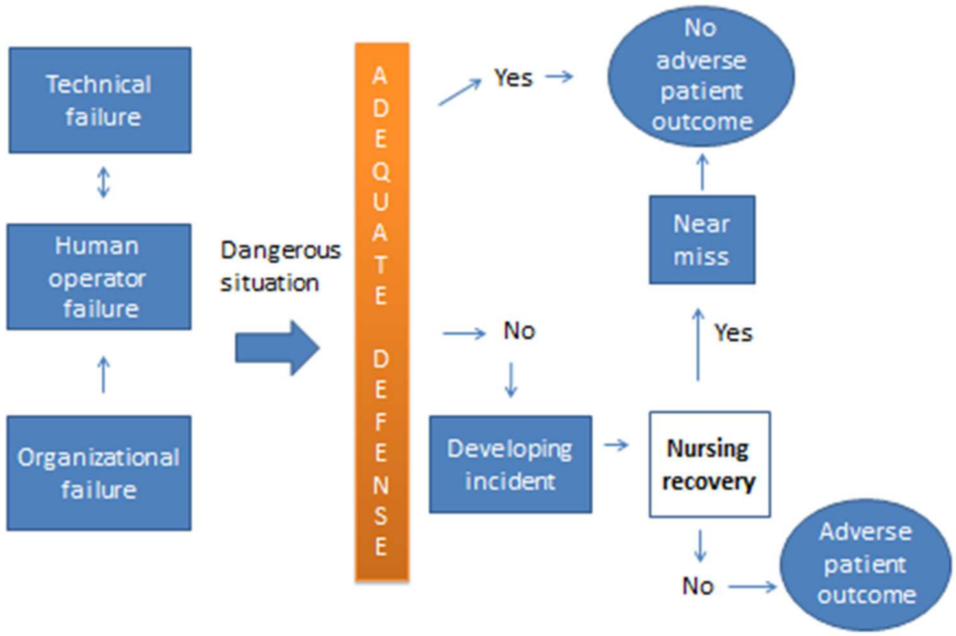

***Figure* 1.** From “A “Near-Miss” Model for Describing the Nurses’ Role on the Recovery of Medical Errors,” By E. Henneman and A. Gawlinski, 2004, *Journal of Professional Nursing*, *20* p. 197. Copyright 2004 by Elsevier. Reprinted with permission.

Through each phase of successful recovery, nurses engage their clinical reasoning skills to detect patient deterioration and environmental risks. Nurses who do not possess strong clinical reasoning skills may be unable to differentiate between incidents needing immediate attention and those that are less serious. Possessing finely tuned clinical reasoning skills allows the nurse to stay highly attuned to both the patient and environment by gathering data, analyzing situations, and weighing actions (Benner, 2001). Although the unique contribution of nurses in the error recovery has been recognized, factors that facilitate medical error recovery have not been explored.

Understanding the relationship between nurse characteristics, organizational factors, and successful error recovery is a key step in the journey to reduce medical errors.

Conceptual Model, Study Variables, Conceptual and Operational Definition of Terms

The conceptual model for this study (Figure 1) was developed based on the Eindhoven Model of Incident Causation (van der Schaaf, 1992). This model emerged from the human factors field as a way to understand safety dilemmas and was subsequently applied to health care environments. Henneman and colleagues (2010) applied the Eindhoven Model to nursing practice environments and modified the model to describe the nurse's role in error recovery.

Definition of terms.

Medical error. "failure of planned actions to be completed as intended or when the wrong plan is used to achieve an aim" (IOM, 2000, p. 28).

Medical error recovery. Identifying, interrupting and correcting medical errors (Henneman et al., 2010). Successful error recovery occurs when errors are identified, interrupted, or corrected before patient harm occurs (IOM, 2000).

Near-miss event. A potentially harmful error that could have reached the patient, but did not because the medical error was recovered (Rothschild et al., 2005). Medical errors that are prevented are considered near misses (IOM, 2004).

This study explored the frequency of medical errors recovered by medical-surgical nurses in hospitals and identified individual nurse characteristics and organizational factors that predict the recovery process.

Independent variables.

There are many variables that influence the recovery process. While technical and organizational factors such as physical design, new technology, and resource availability may affect the recovery process, this study focused only on (1) specific individual or human factors that affected the recovery process and (2) organizational factors that reflected safe nursing practice and influence the recovery process.

Nurse characteristics. Relationships between descriptive demographic variables related to nurse characteristics and the main study variables were examined. These variables were selected specifically to acknowledge each participant's unique individual characteristics within the group. Individual RN characteristics that were examined in this study included age, the highest level of nursing education, specialty tenure, hospital tenure, certification, nursing expertise, and personality.

Age. The majority of quantitative studies exploring recovered medical errors among nurses reported age as a demographic variable (Dykes, Rothschild, & Hurley, 2010; Rogers, Dean, Hwang, & Scott, 2008; Wilkinson, Cauble, & Patel, 2011; Yang et al., 2012). The mean chronological age of nurses in these studies ranged from 44 to 47 years. Sample ages were compared to the National Sample Survey of Registered Nurses (U. S. Department of Health and Human Services Health Resources and Services

Administration, 2010) which reported the mean age of the nursing workforce as 47 years. Recovery processes may develop differently based on age; therefore, it was reasonable to examine the relationship between the age of the nurse and recovered medical errors.

Education. The majority of studies exploring recovered medical errors among nurses were conducted among highly specialized nurses in critical care, perioperative, and emergency nursing settings. While demographic data were collected, research findings have not differentiated outcomes by level of education.

A growing body of evidence indicates that a higher level of nursing education is associated with better patient outcomes (Aiken et al., 2011; Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Dunton, Gajewski, Klaus, & Pierson, 2007). Specifically, hospitals with a higher proportion of baccalaureate prepared nurses have lower mortality and failure to rescue rates. Recovery processes may develop differently among nurses prepared at different levels.

Experience. The literature highlights the importance of experience in the nurse's ability to provide safe care (Benner, 2001; Gillespie, Chaboyer, Wallis, & Werder, 2011; Hill, 2010; McHugh & Lake, 2010). Experience must be meaningful within a specific area of practice and setting. Both specialty tenure and facility tenure was measured.

Specialty tenure was defined as the total length of time, in years, an RN had been practicing within their specialty area. While both experienced and inexperienced nurses apply clinical reasoning skills when providing nursing care, outcomes may differ. For example, nurses working consistently with the same patient population gain advanced nursing skills to transform their practice (Bobay, Gentile, & Hagle, 2009). These nurses gather data and note subtle changes in their patient's, analyze situations, anticipate problems, weight actions and avoid negative consequences (Roche, Morsi, & Chandler, 2009). Although studies evaluating recovered medical errors reported experience as a demographic variable, few studies examined experience in relation to successful recovery processes. Thus, it was reasonable to examine the relationship between specialty tenure and recovered medical errors in this study.

Facility tenure was defined as the length of time, in years, a nurse had been employed at their current hospital. Hospitals are complex environments with many interdependencies including people, teams, technology, structure, culture, and information (Morag et al., 2012). While the health care industry has made great strides in standardization, differences in culture, technology, devices, and layouts between hospitals remain (Lewis et al., 2011). Error recovery processes may develop differently based on length of tenure at the facility. It was reasonable to examine the relationship between these variables in the study.

Certification. Certification exams validate cognitive knowledge (Boltz, Capezuti, Wagner, Rosenberg, & Secic, 2013; Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011). Although certification does not equate to competence, certified nurses have demonstrated a higher knowledge of care and acknowledge a greater sense of self-confidence (Boltz et al., 2013; Wade, 2012). Nurses who are more confident are more willing to engage in the error recovery process (Henneman et al., 2010). The relationship between certification, specifically medical-surgical certification, and patient safety is a fairly new area of research. Studies quantitatively documenting the relationship between patient outcomes and specialty certification among registered nurses are inconclusive. It was reasonable that the relationship between certification and recovered medical errors was examined.

Expertise. Expert nursing practice requires complex decision-making in uncertain environments (Bobay et al., 2009). This variable was defined using Benner's levels of performance that demonstrate progressive stages of skill acquisition (Benner, 2001). Nurse's self-reported level of expertise strongly correlates with peer assessments (as cited in McHugh & Lake, 2010). As nurses progress from novice to expert, they are increasingly able to process information rapidly on both conscious and unconscious levels (Morrison & Symes, 2011). Expertise is influenced by years of nursing experience; although, not all experienced nurses become experts (Hill, 2010; McHugh & Lake, 2010; Roche et al., 2009). When critical situations arise, less experienced nurses apply rules and protocols differently than experts. The relationship between expertise and medical error recovery has not been examined among medical-surgical nurses. Thus, it was reasonable to examine the relationship in this study.

Personality. The main study variable was examined in relationship to personality. The empirical literature linked personality and performance. Previous studies specifically related personality traits such as extraversion with performance (Ellershaw, Fullarton, Rodwell, & McWilliams, 2015; Scheepers, Lombarts, van Aken, Heineman, & Arah, 2014). To date, the relationship between personality and medical error recovery has not been examined. Thus, it was reasonable to examine the relationship in this study.

Organizational factors. The relationship between organizational factors and the main study variable was examined. These variables were selected as they were based on a framework that encompassed safe, supportive practice environments. Such environments enable nursing performance that is associated with better patient outcomes (Hughes, 2008; Lundmark, 2008). The organizational factors to be examined include Magnet designation and workload.

Magnet designation. Magnet-designated hospitals are those hospitals that excel in nursing care and demonstrate quality patient care (McClure & Hinshaw, 2002). Magnet hospitals employ larger numbers of higher educated, certified nurses. Implementing a Magnet model has been associated with a significantly improved nursing practice environment as well as improved patient outcomes (Aiken, Buchan, Ball, & Rafferty, 2008; Kelly, McHugh, & Aiken, 2012; McHugh et al., 2013) This designation is recognized by US News & World Report in their annual assessment of the nation's best hospitals (Comarow, 2010). It was reasonable to examine the relationship between Magnet designation and recovered medical errors.

Workload. Workload has been a key variable of interest for many researchers examining patient outcomes (de Cordova, Phibbs, Schmitt, & Stone, 2014; Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2011; Harless & Mark, 2010; Patrician et al., 2011). de Cordova et al. defined workload as the average number of patients a nurse was assigned per shift during the previous three months. Nurse staffing has been found to be one of the most consistent factors influencing patient outcomes (Aiken et al., 2011; Bobay et al., 2009; Curtin, 2003; Dunton et al., 2007). de Cordova and colleagues (2011) found that errors occurred more frequently on shifts when there were fewer nurses assigned.

Several studies examined workload and medication administration errors (MAE) (Flynn et al., 2012; Patrician et al., 2011). A study of 13 military hospitals found that fewer MAEs were associated with higher RN staffing. A ten percent increase in RNs on medical-surgical units was associated with 1.13 fewer medication administration errors 95% CS [1.04-1.23] (Patrician et al., 2011). In contrast, a study of medical-surgical units in 14 New Jersey hospitals examining the relationship between RN staffing and recovery of medication errors found that nurse staffing was not associated with error recovery ($p \leq .073$) (Flynn et al., 2012). These studies are limited by the use of incident reports as their source of data, and the under-reporting of medical errors is well known.

Since medical-surgical nurses are challenged daily with managing five to six interventions for up to ten different conditions, adequacy of the workload may have important implications about errors (Hanink, 2010). As such, it was reasonable to explore the relationship between nurse workload and recovered medical errors.

Dependent or outcome variable.

The dependent or outcome variable for this study was recovered medical errors as measured using the Recovered Medical Error Inventory (RMEI). The error recovery process is a three-step process consisting of identifying, interrupting, and correcting errors; thereby, preventing patient harm (Henneman et al., 2010; van der Schaaf & Kanse, 2000). For this study, recovered medical errors were errors that were identified, interrupted or corrected by medical-surgical nurses in acute care hospitals; thereby, preventing patient harm (Dykes, Rothschild, & Hurley, 2010). Error recovery strategies have been studied in critical care, operating room, and emergency nurses. No studies have examined the role of medical-surgical nurses in error recovery (Dykes et al., 2010; Henneman et al., 2010; Henneman, Blank, Gawlinski, & Henneman, 2006; Hurley et al., 2008; Yang et al., 2012).

Workload.

The aviation industry offers insight into the relationship between workload and error recovery. A study conducted by Wioland and Amalberti (1998) found that fewer errors occurred as workload increased. Flight crews, however, recovered fewer errors at high workload.

The relationship between the nurse workload and patient outcomes has been examined in several studies (Aiken, Sloane, Bruyneel, Van den Heede, & Sermeus, 2013; de Cordova et al., 2014; Estabrooks et al., 2011; Harless & Mark, 2010; Patrician et al., 2011). Nurse staffing has been found to be one of the most consistent factors influencing patient outcomes (Aiken et al., 2011; Bobay et al., 2009; Curtin, 2003; Dunton et al., 2007). A study examining 283 hospitals in California found that changes in nurse staffing were associated with lower mortality and failure to rescue rates (Harless & Mark, 2010). In an examination of 185 nursing units in Veterans Administration hospitals, de Cordova and colleagues (2014) found that errors occurred more frequently on shifts when there were fewer nurses assigned. Lucero, Lake, and Aiken (2010) conducted a secondary analysis of cross-sectional data to examine the relationship between nursing care and patient outcomes. They found that between 26% and 74% of nursing care was left undone suggesting that errors may be averted with increased nursing hours. A study of 33,659 medical-surgical nurses in 12 European countries reported nurse to patient staffing ratios ranging between 1 to 5 and 1 to 10 (Aiken, et al., 2013). They further reported that errors occurred several times per week.

Several studies examined workload and medication administration errors (MAE) (Flynn et al., 2012; Patrician et al., 2011). A study of 13 military hospitals found that fewer MAEs were associated with higher RN staffing (Patrician et al., 2011). In contrast, a study of medical-surgical units in 14 New Jersey hospitals examined the relationship between RN staffing and recovery of medication errors (Flynn et al., 2012). The researchers found that nurse staffing was not associated with error recovery.

Demographic variables.

The demographic variables in this study included: gender, employment status, role, shift, schedule, hospital type, and hospital size. Demographic characteristics gender, role, hospital type, and hospital size were included in some studies examining recovered medical errors (Dykes et al., 2010; Rogers et al., 2008; Yang et al., 2012). These variables were used to describe the study population and relationships were not examined. The variables shift, schedule, and employment status have not been examined in relationship to recovered medical errors. (Table 1).

Table 1

Conceptual and Operational Definitions of Variables

Variable	Conceptual definition	Operational definition
	Dependent or outcome variable	
Recovered medical errors	The number of medical errors identified, intercepted, and corrected by medical-surgical nurses during the previous three months measured by the Recovered Medical Error Inventory (Dykes, Rothschild, & Hurley, 2010)	Questions R2-R27
	Nurse characteristics	
Age	Age in years	Question 13
Education	The highest level of nursing education obtained (McHugh & Lake, 2010)	Question 6
Specialty tenure	The number of years the participant has been actively practicing in this specialty area (Wade, 2009)	Question 4
Facility tenure	The number of years the participant has been employed at the hospital (Wade, 2009)	Question 5

Certification	Credentialed as a certified nurse in a nursing specialty (American Nurses Credentialing Center, 2013)	Questions 7-8
Expertise	Self-reported level of nursing skill (Benner, 2001)	Question 9
Personality	Self-reported personality traits (Gosling, Rentfrow & Swann, 2003)	Question P1
	Organizational factors	
Magnet designation	The hospital has achieved Magnet designation from the American Nurses Credentialing Center (American Nurses Credentialing Center, 2013)	Questions 10-11
Workload	Average number of patients assigned per nurse per shift during the previous three months (Olds & Clarke, 2010)	Question 18
	Demographic variables	
Gender	Gender of the participant	Question 12
Role	Assigned role on the nursing unit	Question 15
Work schedule	Average work schedule during the past three months (Trinkoff et al., 2010)	Question 16
Shift length	Average hours worked per day during the past three months (Trinkoff et al., 2010)	Question 17

Employment status	Employed full-time, part-time or per diem (Xue, Aiken, Freund, & Noyes, 2012)	Question 14
Hospital type	Type of hospital (Landrigan, 2010)	Question 20

CHAPTER TWO: LITERATURE REVIEW

This chapter summarizes the literature related to medical errors, the medical error recovery process, and the study variables. This review was focused on research conducted within the health care field; although, this study was motivated by the research on error recovery conducted in manufacturing, chemical, aviation, and technology industries. Research related to human factors and medical errors, the recovery process, and nurse's role in patient safety was discussed. The literature review included a methodological review and concluded with an analysis of studies examining the relationship between nurse characteristics and organizational factors and patient outcomes.

A literature review was conducted to evaluate the current evidence about recovered medical errors. Electronic databases (CINAHL, Cochrane Library, MEDLINE/PUBMED, and PsycINFO) were searched from January 2000 to January 2015 to identify studies of recovered medical errors. Studies conducted earlier than 2000 focused more on a broad definition of quality and less on patient safety (Thornlow, 2008). The following search terms yielded the most compelling results: recovered medical error(s), medical error(s), adverse event(s), near miss, close call, prevent or prevention, nurses and patient safety. Using both ancestry and descendancy approaches additional studies were identified. Finally, a search of the gray literature such as bibliographies, technical report, and dissertations yielded further studies.

The Human Contribution to Medical Errors

Human factors engineering recognizes the importance of environmental, organizational, and human-system factors to the evolution of errors (Etchells, O'Neill, & Bernstein, 2003; Reason, 1990; van der Schaaf, 1992). Commonly referred to as human factors, this area of science focuses on how people, work environments, and organizational systems affect safety and human performance (Carayon, 2007; Hughes, 2008; Odukoya, 2013). When dangerous situations develop, the automatic defenses within complex systems are generally able to adapt to fend off negative outcomes. In the case of high-risk situations, however, automatic system defenses are not sufficient to resolve the incident or error (van der Schaaf & Kanse, 2000). Human operators must initiate the recovery process to prevent negative consequences.

James Reason, a clinical psychologist and a recognized leader in the field of human factors, described vulnerable systems using a Swiss-cheese analogy (Reason, Carthey, & de Leval, 2001; Reason, 2012). When slices of Swiss-cheese are aligned, the holes in the cheese do not provide a perfect trajectory. Thus, the system acts as a natural barrier to the occurrence of preventable errors. When environmental, organizational, and human factors components of a complex system align, it is much like the holes in cheese aligning to provide a perfect trajectory through which preventable errors pass.

The Institute of Medicine's landmark report, *To Err is Human* (2000) caught the attention of health care providers as well as the public when it reported that as many as 98,000 medical errors resulted in patient deaths annually. Researchers examined the high rate of medical errors and found that as many as 43.5% of errors were preventable (de Vries, Ramrattan, Smorenburg, Gouma, & Boermeester, 2008; Levinson, 2010). Thus, efforts to improve patient safety by reducing medical errors became a national focal point. The IHI launched the 100,000 Lives Campaign aimed at preventing 100,000 medical errors between 2006 and 2008 (Berwick, 2005). Technology supported solutions such as computerized physician order entry, bar coding, and electronic medical records were instituted to reduce medication errors (Chassin & Loeb, 2013). Further, the AHRQ encouraged hospitals to share innovative solutions to this complex problem (Agency for Healthcare Research and Quality, 2014). As a result, initiatives to improve system performance and standardize processes led to the creation of guidelines to prevent medication errors, protocols to eliminate hospital-acquired infections, and checklists to reduce wrong site surgeries (Pham et al., 2012).

Despite a concerted national focus on improving patient safety in hospitals over the past decade, patients continue to experience preventable medical errors (Chassin & Loeb, 2013; Classen et al., 2011; James, 2013; Landrigan et al., 2010). A study of 183 hospitals conducted by the Centers for Disease Control (CDC) found that despite focused programs to reduce device-related infection, 24% of participating hospitals reported such infections (Magill et al., 2014). A study of three tertiary care hospitals in the United States found that 33% of patients experienced a medical error (Classen et al., 2011). A study of 100 hospitals in North Carolina found similar error rates of which 63% were preventable (Landrigan et al., 2010). A study conducted by the United States General Accounting Office (GAO) found that 13.5% of hospitalized Medicaid beneficiaries experienced a medical error of which 44% were preventable (Levinson, 2010). Given the continuing high medical error rate, James (2013) conducted a retrospective chart review, using the Institute for Healthcare Improvement Global Trigger Tool methodology that provides a standardized process for the identification of medical errors. He estimated that the number of patient deaths attributable to medical errors was closer to between 200,000 and 440,000 annually. Regardless of how much we standardize and automate the structures and processes of complex systems, the human factor cannot be completely eliminated (Hughes, 2008; Reason, 1990; van der Schaaf & Kanse, 2000). In many instances, errors can be detected and correct thus preventing patient harm. Given that human error is inevitable, a focus on error recovery is an important step toward keeping patients safe (Burke, 2014; Habraken & van der Schaaf, 2010; IOM, 2004).

Recovering Medical Errors

The Eindhoven Incident Causation Model is often used to examine relationships and root causes of errors (van der Schaaf, 1992). According to the model, technical, organizational, or human failures result in dangerous situations. Although the model is one of incident causation, it also proposes that errors can be prevented by adequate system defenses (van der Schaaf & Kanse, 2000). If the built-in system defenses are not able to control the incident, the flexibility, experience, and intuition of the human operator must stop the unintended chain of events. A near miss or preventable medical error results when a potential incident is averted. It is important to note that the recovery process is the unique determining factor between a medical error resulting in patient harm and a near miss.

The importance of error recovery has been extensively studied in other complex industries such as aviation, maritime, computing, and manufacturing processes (Amalberti, 1998; Courtright, Stewart, & Ward, 2012; Helmreich, 2000; Rizzo, Bagnara, & Visciola, 1987; van der Schaaf, 1995). The recovery process is defined as "the feature of the human system component to detect, localize and correct earlier component failures" (van der Schaaf & Kanse, 2000 p. 28). There are three sequential phases of the recovery process. Although theorists have used different terms to define the phases, the three-part process is consistent (Blavier et al., 2005; Henneman et al., 2010; Jambon, 1997; Kontogiannis & Malakis, 2009; van der Schaaf & Kanse, 2000) First, an error must be detected. Identification or detection of the error is the process of knowing that an error occurred. A mismatch in the expected outcome or an attentional tool such as a checklist can stimulate this sense of knowing. Intercepting or understanding the nature of the error is the second phase. In this phase, the participant is attempting to gather an explanation of how the error occurred. Finally, the third phase is correcting or counteracting the error. In this phase, the focus is on suppressing the error by revising the plan or initiating a new plan.

To date, medical error recovery has been viewed more as a spontaneous process and briefly mentioned within the broader context of studies of medical errors. For example, one of the first studies of errors conducted in two tertiary care hospitals, identified 247 medication errors of which 28% were considered preventable (Leape, 1997). The study further noted that nurses most frequently identified the errors. The Critical Care Safety Study conducted by Rothschild et al. (2005) in two critical care units of a tertiary care hospital found 20% of patients experienced a medical error, 66% of which were preventable. Nurses discovered 36% of the errors.

There are several ways to classify errors. The most prominent classification system is that of Reason's (1990) cognitive based stages; skill-based slips, rule-based mistakes, and knowledge-based mistakes. Slips are actions that deviate from intentions and occur when attention momentarily lapses. The resulting errors can be recovered using cues. Mistakes result when the plan is inadequate to achieve the expected outcome and recovery requires higher level cognitive processes. As errors cannot be eliminated, it is important to reduce their consequences. Error recovery is also described based on these cognitive stages (Blavier et al., 2005; Reason, 1990). According to researchers, skill-based errors are the easiest to detect and detection rates decline as errors become more complex (Amalberti, 1998; Reason, 1990). An observational study of 18 surgical procedures identified a total of 200 errors that were recovered (Yang et al., 2012). Of these recovered errors, 79% were skill-based. An observational study of critical care nurses over the course of 308 hours found that nurses recovered 142 errors (Rothschild et al., 2006). Again skill-based errors (56%) were recovered more frequently than rule-based (4%) or knowledge-based errors (41%).

Both positive and negative factors can influence the recovery process. A variety of characteristics and conditions may strengthen or weaken an individual's ability to detect and correct errors. When error recovery is successful, and patient harm is averted, it is deemed a near miss. A study of 31 recovered medication errors in a Dutch hospital pharmacy found that individual knowledge and expertise were key positive factors in recovering the error and preventing patient harm (Kanse, van der Schaaf, Vrijland, & van Mierlo, 2006). Unsuccessful error recovery opportunities also offer valuable information, particularly regarding negative factors that impact the process. In this same study, the most dominant failure factor was organizational culture. When the culture of safety was not a high priority, safety checks were missed and established protocols were not followed.

Medical errors not only harm patients but negatively impact the health care system as well. A study of medical claims reported that the financial burden born from medical errors in 2008 was $17 billion (Jill et al., 2011). Today estimates are closer to $37 million (De Meester et al., 2013). Examining secondary data obtained from the Critical Care Safety Study, Rothschild et al. (2006) determined that costs savings from recovered errors ranged from $2 to $13 million annually. When compared to the cost of nurse staffing, it was found that the most expensive staffing model was less costly than projected savings from recovered errors. Nurses are a cost-effective safety mechanism.

Studies indicate that nearly half of all medical errors are preventable (De Meester et al., 2013; James, 2013). A better understanding of the role of nurses in error recovery is needed, particularly since nurses are the health care provider most likely to identify, interrupt, and correct medical errors to prevent or mitigate patient harm.

Error Recovery Process and Nursing Practice

As frontline clinicians at the point of care, nurses are uniquely poised to recover medical errors. In the health care system, when built-in system defenses do not automatically avert potentially dangerous situations, nurses are the direct care providers who serve as the final barrier of defense to prevent patient harm (Aiken, Smith, & Lake, 1994; Lundmark, 2008). Although the key role nurses play in keeping patients safe has been broadly recognized, there is a limited research on the frequency of errors recovered by nurses.

A diary-based descriptive study of 502 critical care nurses explored the frequency with which nurses' detected medical errors (Rogers et al., 2008). Researchers found that individual nurses identified between zero and 12 errors in a 28-day period. Of these, medication errors were most frequently recovered. An observational study of seven nurses was conducted in a coronary care unit of a tertiary medical center (Rothschild et al., 2006). Using the Eindhoven Incident Causation Model as their framework, researchers found that nurses identified, interrupted, and corrected 142 medical errors over the course of 147 days. Of these, medication errors were the most frequently recovered errors, and most errors (69%) were interrupted before patient harm occurred. A study of 345 critical care nurses was conducted by Dykes, Rothschild, and Hurley (2010) using the Recovered Medical Error Inventory (RMEI) to assess nurses' recovery of medical errors. The instrument was used to measure both frequency and severity of recovered medical errors. The study indicated that, on average, each nurse recovered one medical error per week, of which 25% were considered potentially lethal. A prospective observational study of 18 cardiovascular surgical procedures was conducted to assess the incidence and type of errors recovered by operating room nurses (Yang et al., 2012). Of the 200 errors that were observed during these surgical procedures, 61% were defined as potential errors, while 39% occurred. Of the errors that occurred, 77% were intercepted, and 23% were corrected to prevent patient harm.

Although the important role of nurses in recovering errors has been recognized, and studies have attempted to quantify the number of errors nurses recover, little is known about how nurses recover errors. Several studies used a qualitative approach to examine the phenomenon of medical error recovery among nurses. Four studies examined the error recovery strategies used by nurses in specialized areas (emergency department and critical care) (Balas, Scott, & Rogers, 2004; Henneman et al., 2010; Henneman et al., 2006; Hurley et al., 2008). One study examined nurses in a variety of acute care hospital units (Balas, Scott, & Rogers, 2004). Another study focused solely on recovery practices during medication administration (Flynn et al., 2012). Throughout the six studies, consistent themes emerged regarding strategies nurses used to recover errors; 1) knowing the patient, 2) understanding the big picture, 3) questioning and verifying, and 4) advocating for the patient.

Nurses emphasized the importance of knowing the patient (Balas et al., 2004, 2006; Flynn et al., 2012; Henneman et al., 2010; Henneman et al., 2006; Hurley et al., 2008). Being familiar with all aspects of the care plan helped them identify potential errors. For example, being familiar with the tests, diet, therapy, and medications allowed nurses to recognize when something was not right. Nurses further stressed the importance of taking all clinical factors into consideration during the care process. For example, nurses incorporated clinical factors such as laboratory values, vital signs, and allergies into decision-making processes when identifying and intercepting errors. One strategy nurses frequently used in intercepting and correcting errors involved questioning and verifying. For example, nurses questioned physicians or colleagues during shift report. This strategy allowed nurses the opportunity to review the plan of care in a positive manner. Also, nurses frequently consulted expert nurses when questioning orders and procedures. Advocating for the patient is a standard expectation of nursing practice and is a strategy often used to interrupt or correct medical errors. For example, nurses advocate for patients when obtaining missing medications, making requests to physicians to obtain appropriate pain medication, or hunting down equipment for patients.

The three stages of the recovery process; identification, interruption, and correction, align with strategies nurses use to recover medical errors. Factors such as knowing the patient, players, plan of care and the environment aid in the identification of an error. Nurses interrupted errors using actions such as offering assistance or clarifying orders. Finally, nurses referred to the plan of care, standards, or experts when correcting errors. When the potential for an adverse event was high, nurses offered verbal warnings to stop an activity.

Assessment and ongoing surveillance are primary nursing functions. Surveillance and double-checking emerged as a technique used by both critical care nurses and emergency department (ED) nurses to recover errors (Henneman, Gawlinski, & Giuliano, 2012). Nurses provide ongoing assessment and surveillance to detect subtle changes in status and prevent complications. Whereas critical care nurses continually synthesized data related to the patient, ED nurses expanded their surveillance to include the environment.

Recovering medical errors is an important strategy for keeping patients safe. While everyone, including the patient, has a role in preventing harm, nurses are uniquely positioned to recover medical errors before harm occurs. The modified Eindhoven Incident Model provides a framework to explore the unique role of nurses in the recovery process. Uncovering positive and negative factors that influence medical error recovery will provide an impetus for the development of educational strategies to enhance error recovery skills among nurses and enable organizations to maintain high levels of safety.

Methodological Review

Several instruments were widely used to detect and measure medical errors; however, no gold standard exists. AHRQ uses a retrospective chart review method based on administrative data to identify medical errors (Naessens et al., 2009). Potential medical errors are identified through computer generated algorithms developed by

AHRQ. One of the weaknesses of this instrument is that it may include conditions present upon admission.

State-level reporting uses provider-reported data based on the National Quality Forum's list of never events to report hospital-based errors. In these instances, health care providers report both errors and near misses using locally developed instruments (James, 2013; Landrigan et al., 2010). While these instruments report real-time events and are thought to be more sensitive measures of patient harm, one of the weaknesses is a lack of standardization.

Medical record abstractions using trigger tools identify specific criteria or triggers to generate the sample from which more extensive analysis will be conducted is gaining popularity. The IHI's Global Trigger Tool is widely used to assess medical errors (Classen et al., 2011). While this tool has been proven to detect errors, it is reviewer intensive.

Although these instruments have contributed to a more comprehensive understanding of patient safety, assessing the frequency of medical errors remains complicated by laborious systems and the lack of standardized reporting. The fear that reports will be used against them further complicates underreporting by health care providers (Barnsteiner & Disch, 2012; Lewis et al., 2011). Physicians and nurses alike may be reluctant to report errors that may cause professional damage. As such, errors that are intercepted before they reach the patient are rarely reported (IOM, 2004; Leape, 1997). Recovered errors occur 7-100 times more frequently than medical errors (IOM, 2004).

Measurement instruments to quantify the frequency with which nurses recover medical errors are just emerging. Attempts to quantify the number of medical errors identified, interrupted, and corrected by nurses have been studied using a variety of data collection methods with the most prominent being observation and log books. Studies using observation and log book to collect data, however, require extensive resources. Dykes, Rothschild, and Hurley (2010) developed the Recovered Medical Error Inventory (RMEI) to measure the frequency and severity of medical errors recovered by critical care nurses. The RMEI is a 25-item inventory that measures the incidence, seriousness, and lethality of recovered medical errors. The instrument was tested with critical care nurses and demonstrated good internal consistency (α .90) (Dykes et al., 2010). A one-year study of 345 critical care nurses found that nurses intervened approximately once a week and recovered a total of 18,578 medical errors over the course of one year (Dykes et al., 2010). It was anticipated that nurses would have recovered a total of 70,702,000 medical errors per year when these findings were extrapolated to the nursing workforce.

The RMEI is a recent development and has been used exclusively with critical care nurses. To date, no studies have examined the frequency of recovered medical errors by medical-surgical nurses. This nursing specialty is the largest group of direct care providers which positions them well to recover errors. There are over 400,000 medical-surgical nurses practicing in a variety of areas. In general, the frequency of recovered error remains largely unknown, particularly in the medical-surgical nursing population.

Factors Influencing the Recovery Process

Nurses are the largest component of the health care workforce and key health care providers in hospitals (IOM, 2004). Research findings suggest that registered nurses are the most likely of all health care providers to recover errors (Leape, 1997; Rothschild et al., 2005). Further, it has been well documented that data on recovery processes provides important patient safety information and insight into safety processes (Habraken & van der Schaaf, 2010; Henneman et al., 2010; IOM, 2004; van der Schaaf & Kanse, 2000). Although nurses' role in error recovery is gaining recognition, little is known about what individual characteristics distinguish nurses who are effective at recovering errors. Also, there is a lack of information regarding the relationship between organizational factors and recovered medical errors. Further examination of nurse's role in the recovery process is needed to provide insight into positive recovery factors.

As Ernst Mach (1905) stated, "Knowledge and error flow from the same mental sources, only success can tell one from the other" (as cited in Reason, 1990, p. 1). Individual and organizational factors have been increasingly recognized as contributing to medical errors (Clark, Belcheir, Strohfus, & Springer, 2012; Hughes, 2008). A substantial body of knowledge indicates that nurses' ability to provide safe and efficient care is influenced by both individual nurse characteristics such as knowledge, skill, experience, intelligence, and motivation as well as organizational factors including staffing, safety culture, and resource adequacy (Aiken et al., 2011; Kendall-Gallagher et al., 2011; McHugh et al., 2013; Scott, Sochalski, & Aiken, 1999). Supportive nursing practice environments that enable the best performance from nurses have been significantly associated with lower mortality and failure to rescue rate (Aiken et al., 1994). It has also been noted that nurses working within organizations with impressive safety records possess different characteristics than those in less reliable organizations (Henriksen et al., 2008). Nurses mature in their practice as they gain experiential and practical knowledge. During this journey, they may gain additional formal education, obtain certification, and become recognized experts in a practice area. It is reasonable; therefore, to hypothesize that these individual nurse characteristics may be associated with improved ability to recover medical errors. Further, practice environments, whether they are supportive or safety focused, may also be associated with medical error recovery. To date, the available information regarding the relationship between influencing factors and recovered medical errors was inherent in research focused more broadly on patient outcomes. This study focused on the following individual nurse characteristics: age, education, experience, certification, expertise, and personality as well as the organizational factors of Magnet designation, and workload.

Education.

Registered nurses obtain education through a variety of channels. Entry level registered nurses may be educated through diploma, associate degree, or baccalaureate degree programs. Despite the diversity of educational programs, new graduate nurses must pass the same licensure exam. Given the variety of entry-level nursing education programs, the impact of nursing education on quality of care has garnered much debate among nurses.

Aiken, Clarke, Cheung, Sloane, and Silber (2003) examined the effect of differentiated nursing education levels on patient outcomes. Using a cross-sectional analysis of outcomes data from 168 Pennsylvania hospitals researchers demonstrated a relationship between baccalaureate and master's degree prepared nurses and a decreased risk of mortality and failure to rescue. Subsequent studies conducted by Aiken and others examining the relationship between education and mortality rates supported these findings (Aiken et al., 2011; Blegen, Goode, Shin Hye, Vaughn, & Spetz, 2013; Estabrooks et al., 2011; McHugh & Lake, 2010). A cross-sectional study of 21 University Health System Consortium hospitals examined the relationship between education and several nurse-sensitive patient outcomes (Blegen et al., 2013). Researchers found that hospitals with higher levels of baccalaureate prepared nurses experienced lower rates of hospital-acquired pressure ulcers (HAPU) and lower failure to rescue rates. In contrast, Sales et al. (2008) did not find a significant association between baccalaureate prepared nurses and patient outcomes at the hospital level.

Although the body of evidence examining an association between education and patient outcomes is growing, the evidence remains inconclusive. There are no studies examining nursing education and recovered medical errors.

Certification.

Nursing specialty certification is defined as a mark of nursing excellence (Boltz et al., 2013). In general, certification is a formal recognition of nurses' specialized knowledge, skills, and experience. Specific to medical-surgical nursing, certification demonstrates the achievement of standards required by the medical-surgical nursing specialty to promote optimal health outcomes (Niebuhr & Biel, 2007). Studies quantitatively documenting the relationship between patient outcomes and specialty certification among registered nurses are limited. Studies indicated that certified nurses demonstrated a higher knowledge of care and generally acknowledged a greater sense of self-confidence (Boltz et al., 2013; Haskins, Hnatiuk, & Yoder, 2011; Wade, 2012).

The relationship between certification and patient safety is a fairly new area of research. Although this body of research is growing, the findings remain controversial. Aiken and colleagues (2003) found that specialty nursing certification, in general, was associated with lower mortality. Regarding medical-surgical certification specifically, a study of medical and surgical patients in 652 hospitals found that specialty nursing certification was associated with lower mortality and failure to rescue, but only among nurses with baccalaureate and higher education (Kendall-Gallagher et al., 2011). In contrast, a survey of 450 staff nurses working in 25 intensive care units found there was no relationship between the proportion of certified nurses and three adverse events; central line catheter-associated blood stream infections, ventilator associated pneumonia, pressure ulcers (Krapohl, Manojlovich, Redman, & Zhang, 2010). Finally, a study of 44 medical and medical-surgical units found that specialty certification was a significant predictor of adverse events, specifically patient falls (Boltz et al., 2013).

To date, there are no studies examining the impact of nursing certification on error recovery. The relationship between certification and recovered medical errors was explored since certified nurses possess greater knowledge and confidence, and specialty certification appears to be related to improved patient outcomes.

Experience and expertise.

The relationship between years of RN experience and patient safety has long interested nursing researchers. Several studies explored the link between experience and decreased mortality and failure to rescue (Aiken et al., 2003; Dunton et al., 2007; McHugh & Lake, 2010). An examination of RN characteristics using the National Database of Nursing Quality Indicators (NDNQI) found that for every year of RN experience, the fall rate dropped by 1%, and the hospital acquired pressure ulcer (HAPU) rate was 1.9% lower (Dunton et al., 2007).

Experience does not equal expertise. Clinical nursing expertise is acquired through practical, theoretical, and experiential knowledge that can only be developed over time (Benner, 2001; McHugh & Lake, 2010). Benner's (1984) model of skill acquisition outlines five stages of development; novice, advanced beginner, competent, proficient, and expert. Benner formally defined expertise as fluid, flexible and anticipatory practice demonstrated by nurses who have a demonstrated comprehensive understanding of the situation. While nursing experience is necessary to progress from novice to expert, it is not solely sufficient to reach the expert level.

Roche (2009) examined the relationship between experience and expertise among acute care registered nurses and found that years of nursing experience in general and years of experience on the unit were not associated with expertise. The researchers demonstrated that only experience in the specialty was associated with expertise.

Expertise appears to play a role in error detection and correction (Patel et al., 2011). An ethnographic observational study of core team members in a cardiothoracic intensive care unit examining how errors were detected revealed that a higher proportion of errors were detected and recovered during interactions between team members such as handoffs and rounds (Graham et al., 2004). Intuition, expertise, experience, and the opportunity to ask clarifying questions were factors that contributed to error recovery.

It is suggested that experts accumulate knowledge and experience that combine to form a level of intuition that supports the process of error recovery (Benner, 2001; Patel et al., 2011). A descriptive study of 25 surgical attending and resident physicians; however, found no significant difference between experts and non-experts in detecting medical errors ($r = 0.117$, $p \leq 0.58$) (Patel et al., 2011). Attending physicians with experience ranging from one to 20 years were defined as experts while residents were defined as non-experts. The study did find more subtle differences between the two groups regarding the recovery process. For example, experts were more likely to correct errors when detected, and non-experts were more cautious in their error recovery patterns.

In contrast, Wilkinson, Cauble, and Patel's (2011) study of 31 nurses working in hemodialysis units found that expert nurses ($\chi 2 = 9.94$, $p \leq 0.01$) detected significantly more errors that non-expert nurses. The researchers defined expert nurses as those with ten years or more experience in caring for patients on hemodialysis.

Expertise in both of the studies noted above was defined by years of experience; yet, length of service and expertise are not the same (Redman, 2008; Roche et al., 2009). Nursing expertise is demonstrated by clinical reasoning and decision-making of which years of nursing experience is one of many contributing factors. While some nurses can demonstrate nursing expertise in as few as five years, others may work for many years in the profession and never achieve expert practice (Roche et al., 2009).

Magnet designation.

The American Nurses Credentialing Center (ANCC) formalized the Magnet Recognition Program in the 1990s (McClure & Hinshaw, 2002). Over time, Magnet-designated hospitals have evolved from being good places for nurses to work to organizations that provide high-quality, safe patient care (Leapfrog Group, 2014). Magnet hospitals strive for and must demonstrate evidence of excellence in five areas; transformational leadership; structural empowerment; exemplary professional practice; new knowledge, innovations, and improvements; and empirical outcomes that together create positive work environments. Hospitals receiving Magnet designation demonstrate positive practice environments that enable nurses to provide high quality, safe, care (Ulrich, Buerhaus, Donelan, Norman, & Dittus, 2007). Today, 8% of the nation's hospitals are nationally recognized as Magnet hospitals (McHugh et al., 2013).

In one of the first studies to examine patient outcomes in Magnet hospitals, Aiken et al. (1994) conducted a cross-sectional multivariate study examining mortality rates in 39 Magnet hospitals as compared to 195 non-Magnet hospitals. Researchers found lower risk-adjusted mortality rates among Medicare patients in Magnet hospitals. Since this initial study, additional research findings suggest that Magnet hospitals provide safer work environments for both patients and nurses as compared to non-Magnet hospitals (Aiken et al., 2008; Goode, Blegen, Park, Vaughn, & Spetz, 2011; Kelly et al., 2012; Laschinger & Finegan, 2005; Scott et al., 1999; Ulrich et al., 2007)

Specifically examining nurse and hospital characteristics, Kelly, McHugh, and Aiken (2012) conducted a cross-sectional study to determine differences between Magnet and non-Magnet hospitals. Surveying nurses working in Magnet and non-Magnet hospitals (n = 4,652/21,714) across four states, researchers tested differences between the two groups and found that Magnet hospitals had more positive work environments as measured by the Practice Environment Scale of the Nursing Workforce Index (PES-NWI). Using secondary data from the above-noted study in addition to administrative data, the researchers examined whether patient outcomes differed between Magnet and non-Magnet hospitals. After adjusting for patient characteristics and other hospital factors, the findings indicated that patients in Magnet hospitals had 14% lower odds of inpatient death within 30 days, and 12% lower odds of failure-to-rescue compared with patients cared for in non-Magnet hospitals (McHugh et al., 2013).

A study of medical-surgical units in 14 New Jersey hospitals examined the relationship between positive practice environments and recovery of medication errors (Flynn et al., 2012). Using the PEW-NWI, researchers examined five subscales: (a) nursing participation in hospital affairs, (b) nursing foundations for quality of care, (c) collegial nurse-physician relationships, (d) supportive and competent nurse manager, and (e) staffing and resource adequacy. The researchers found that nurse staffing was not significantly associated with error recovery. The subscales of collegial nurse-physician relationships and nursing foundations for quality of care showed the strongest correlations.

Demographic Variables

Demographic characteristics gender, role, hospital type and hospital size were included in some studies examining recovered medical errors (Dykes et al., 2010; Rogers et al., 2008; Yang et al., 2012). These variables were used to describe the study population and relationships were not examined.

In summary, the literature review revealed that a limited number of studies examined the frequency of recovered medical errors by nurses. The published research in this area focused on strategies of specialty nurses to recover medical errors. While studies have examined nurse characteristics and organizational factors as they relate to patient outcomes, only a few studies examined the relationship between these variables and recovered medical errors among nurses. Further, the majority of published research related to medical error recovery by nurses was conducted using convenience samples and data were aggregated to include nurses at all ages and educational preparation without differentiation of results by certification or expertise. Further, results were not differentiated by organizational factors including Magnet recognition, and nurse workload.

Nurses are well positioned to stop medical errors before they cause patient harm. As frontline providers, nurses serve as the last barrier of defense by identifying, disrupting, and correcting medical errors. Although research related to medical errors has grown in the past 15 years, it has focused on causation rather than the phenomenon of recovery. This study, therefore, explored the relationship between RN characteristics (age, education, specialty tenure, facility tenure, certification, expertise, and personality) and organizational factors (Magnet, workload) and recovered medical errors among medical-surgical nurses in hospitals.

CHAPTER THREE: METHODOLOGY

This chapter describes the methodology of the study; including the research design, sampling, data analysis strategies, and research instruments. It also describes human subject review board procedures and ethical considerations for protecting patients.

Research Design

This non-experimental study used a descriptive, cross-sectional, correlational design to examine the association between variables of interest using a quantitative survey instrument. The primary purpose of the study was to examine relationships between individual nurse characteristics (age, education, experience, expertise, certification, and personality), organizational characteristics (Magnet designation and workload) and recovered medical errors among medical-surgical nurses working in hospitals. The secondary purpose was to identify factors predicting recovery of medical errors by medical-surgical nurses in hospitals.

Setting and Sample

Setting. The setting included a four-hospital health care system in western Virginia and a professional nurses association. The health care system consisted of two rural hospitals, one Magnet-designated hospital, and one teaching hospital. There were six medical-surgical units among the four hospitals with 168 RNs that were eligible to participate in this study. For this study, acute care hospitals were defined as critical access, cancer, specialty medical/surgical, children's, federal or state hospitals that provide acute care services (American Hospital Association, 2012). Acute care hospitals were chosen as these settings employ the largest number of medical-surgical nurses and are common settings in which medical errors occur. The professional nurses association consisted of over 100,000 registered nurse members nationwide of which 40% were employed in acute care settings. The association provided an email listing for more than 3800 medical surgical nurses that were part of the second convenience sample. All together the convenience sample totaled 4000.

Sample. The sample consisted of medical-surgical RNs working in the health care system and medical-surgical nurses who were members or customers of the professional nurses association. Inclusion criteria included licensed RNs with computer and email access, who were 18 years of age or older, and currently providing direct care as a medical/surgical nurse in an acute care hospital. Exclusion criteria included nurses who were unable to read and write in English.

The notion of reporting medical errors is sensitive, and many health providers are leery of reporting errors. As such, social desirability response bias was a threat, particularly since a self-report instrument was used in this study (Polit & Beck, 2012). Therefore, the provision of confidentiality was stressed to encourage frank and honest reporting. Key characteristics of the sample were analyzed and compared to reference groups to ensure it was representative of the population.

The sample size was determined by using the Tabachnick (2007) recommended formula N ≥104 + m (where m is the number of independent variables) for testing individual predictors. The sample size for this study was based on regression analysis with ten variables. Using this and an expected 10% nonparticipation rate, a sample size of 4000 nurses was deemed sufficient to provide a medium effect size (R^2 =.13) with a power of .80 and significance level of .05.

Extraneous variables were considered to further strengthen the results of this study. A literature review identified variables found to have confounded the effect of the independent variables on the outcome variable included: gender, position, work schedule, shift length, employment status, hospital type and hospital size. These confounding variables were controlled through statistical analysis.

Study Instrumentation

Participants completed a demographic questionnaire developed by the investigator, the Recovered Medical Error Inventory (RMEI) and the TEN ITEM Personality Inventory (TIPI). A description of these instruments is as follows:

The RMEI is a 25-item instrument designed to measure the frequency and severity of medical errors recovered by nurses (Dykes et al., 2010). This study examined the frequency of recovered medical errors only. The severity of medical errors was not examined. The instrument consists of two subscales called Mistake and Poor Judgment. The Mistake subscale consists of 17 items that measured skill-based and rule-based errors. The Poor Judgment subscale consists of 8 items that measure knowledge-based errors. The frequency of each item was scored on a 4-point scale (zero, once, 2-5 times, or over five times). The total frequency of medical errors recovered was scored by summing the frequency of the 25-items and recoding “zero” as 0, “once” as 1, “2-5” as 3 and “over 5” as 6. The Cronbach alpha’s for the RMEI subscales ranged from .75 (Poor Judgment subscale) to .88 (Mistake subscale). The instrument had an overall internal consistency of .90

Expert review.

The RMEI was developed using qualitative responses and judgment from critical care nurses. Dykes and colleagues (2010) used the RMEI to assess recovered medical errors among critical care nurses. To assess the instrument’s applicability to medical-surgical nurses, two medical-surgical nurse experts reviewed the instrument. The experts concluded that the scenarios included in the RMEI frequently occur on medical-surgical units in hospitals and the instrument was applicable to the study population.

Instrument Pilot Test.

After receiving approval from the George Mason University Office of Research Integrity and Assurance, a pilot study was conducted using a convenience sample of 30 medical-surgical nurses. Participants were recruited from the professional nurses association to evaluate the format of and items in the electronic survey, appropriateness and quality of study instruments, and the strength of relationships between study variables. No instrument revisions were required. The pilot study results were included in the final results.

The Ten-Item Personality Inventory (TIPI) was used to measure personality The 10-item, self-report survey measures broad personality domains (Gosling, Rentfrow, & Swann, 2003). Using a 7-point Likert scale, respondents were asked to rate the extent they agree or disagree with statements concerning their personality. The possible responses ranged from 1) disagree strongly to (7) agree strongly. The reliability for the TIPI domains ranged as follows: (1) Extraversion (0.68), (2) Agreeableness (0.40), Conscientiousness (0.50), Emotional Stability (0.73), and Openness (0.45) (see Table 2). The TIPI has been tested with undergraduate students in multiple countries and has an average correlation of .72 across the five domains (Jonason, P., Teicher, E., & Schmitt, D., 2011).

Table 2

Study Scales, Subscales, and Psychometric Properties

Study Instrument Name	Subscale	Psychometric Properties
Recovered Medical Error Inventory (25 items)	Mistake (17 items) Poor Judgment (8 items)	The Cronbach alpha's for the subscales ranged from .75 to .88. The instrument had an overall internal consistency of .90. This is above the normally acceptable rating of .70 (Dykes et al., 2010)
Ten Item Personality Inventory (10 items)	Extraversion (2 items) Agreeableness (2 items) Conscientiousness (2 items)	The Cronbach alpha's for the subscales were: Extraversion (0.68),

	Emotional Stability (2 items) Openness (2 items)	Agreeableness (0.40), Conscientiousness (0.50), Emotional Stability (0.73), and Openness (0.45). (Gosling, Rentfrow, & Swann, 2003)

Data Collection Procedures

The researcher contacted the chief nursing officers of the four-hospital health care system who expressed interest in participating in the study. The chief nursing officers identified six medical-surgical units that would be interested in supporting the study. With the support of the chief nursing officers, the researcher submitted an application to the health care system's Research Review Committee. After receiving approval from the health care system's Research Review Committee, an executive summary of the study was shared with each point of contact. A review committee was not required at the professional nurses association.

Data were collected using an electronic survey instrument (Qualtrics) with encryption. Study information and informed consent were included on the first page of the survey. Completion of the survey was considered informed consent.

The electronic survey was delivered via electronic transmission to registered nurses through the hospital points of contact. Email notices were sent to a convenience sample of members and customers of the professional nurses association containing a link to the survey and inviting them to participate in the study. This was done to ensure the sample size would be sufficient. Two reminder emails were sent, ten days and 20 days following the initial email, to all points of contact in the four hospitals and the list of nurses obtained from the professional nurses association. Data were collected between October 2014 and January 2015. Participation was voluntary and individual responses were kept confidential and not made available for hospital administrators, points of contact or the professional nurses association.

The survey site was password-protected as was the computer used to access the data to ensure confidentiality. No individual other than the researcher had access to the data. The data set in the electronic survey instrument were deleted following the download of data to the password-protected computer. The IP address, which could link to an individual computer, was also deleted once the data were downloaded onto the password-protected protected computer.

An incentive award was used to entice nurses to participate in the study. Four Amazon gift cards valued at $25 each were awarded to four different nurses participating in the study. To be eligible for the Amazon gift card, participants had to enter an email address when completing the study. All email addresses were maintained confidentially in the password-protected protected computer. The Amazon gift card was awarded to four randomly selected participants. These participants were selected by counting the total number of study participants and using a computer generated program. While an email address was not required to participate in the study, it was required to receive the incentive.

Measurement of Major Study Variables

This section details the independent (IV) (age, education, facility tenure, specialty tenure, expertise, certification, and personality) and dependent (DV) variables (Magnet designation and workload) examined in this study. These variables were chosen based on findings from sound research focused on nurse's role in recovering medical errors (Balas et al., 2004; Henneman et al., 2006; Rogers et al., 2008; Rothschild et al., 2005; Wilkinson et al., 2011; Yang et al., 2012). Measurement of these variables is reported in this section.

Recovered medical errors.

The frequency of recovered medical errors was measured as a count variable using a 4-point scale (zero, once, 2-5 times, or more than 5 times) with the Recovered Medical Error Inventory (Dykes et al., 2010).

Age.

This ratio variable was measured using a single item in which participants were asked to report their age in years.

Education.

This ordinal variable was measured using a single item in which participants were asked to identify their highest level of nursing education completed as either diploma, associate degree, baccalaureate, masters, or doctorate in nursing (Ph.D. and DNP) (McHugh & Lake, 2010).

Specialty Tenure. This ratio variable was measured using a single item in which participants were asked to identify the number of years they had been actively practicing within their specialty (Wade, 2009).

Facility Tenure. This ratio variable was measured using a single item in which participants were asked to identify the number of years they had been employed at their hospital (Wade, 2009).

Certification.

This nominal variable was measured using two items. Participants were asked if they were currently certified in a nursing specialty area (yes/no). If yes, they were asked to identify the specialty (Wade, 2009).

Expertise.

This ordinal variable was measured using a single item in which participants were asked to self-report their level of nursing expertise as novice, competent, or expert (Benner, 2001).

Personality.

This nominal variable was measured using the average item rating from the Ten Item Personality Inventory (Gosling, Rentfrow, & Swann, 2003). The possible responses ranged from 1) disagree strongly to (7) agree strongly.

Magnet designation.

This nominal variable was measured using two items. Participants were asked to identify if the hospital in which they were employed had been designated by the American Nurses Credentialing Center Magnet Recognition Program (yes/no). If no, participants were asked if their hospital was on the Magnet journey (yes/no) (Ulrich et al., 2007).

Workload.

This ratio variable was measured using a single item in which participants were asked to report their average nurse to patient ratio over the past three months between 1:1 and 1:10 nurse per patients (Aiken et al., 2013).

Measurement of Demographic Variables

This section details the demographic variables used to describe the study sample. Measurement of these variables is reported in this section.

Sex.

This nominal variable was measured using a single item in which participants were asked to identify their sex as male or female.

Role.

This nominal variable was measured using a single item in which participants were asked to identify their unit role as a staff nurse, charge nurse, or manager.

Work schedule.

This nominal variable was measured using a single item in which participants were asked to identify their average shift worked during the past three months as day, evening, or night (Trinkoff et al., 2010).

Shift length.

This nominal variable was measured using a single item in which participants were asked to identify their average length of shift worked as four-hours, eight-hours, or twelve-hours (Trinkoff et al., 2010).

Employment status.

This nominal variable was measured using a single item in which participants were asked to identify their status as full-time, part-time, or per diem.

Hospital type.

This nominal variable was measured using a single item in which participants are asked to identify their hospital based on teaching or nonteaching.

Hospital size.

This ordinal variable was measured using a single item in which participants were asked to identify the size of their hospital as small ($\leq$ 50 beds), medium (51-250 beds), or large ($\geq$ 250 beds).

Data Analysis

The primary outcome variable was the summative frequency of recovered medical errors. The relationship between the IVs and DV was examined using bivariate and multivariate analysis. Data were analyzed using SPSS version 23 (SPSS Inc. Corp., Chicago, IL, USA) and Stata SE version 12.1 (StataCorp, College Station, TX, USA). Significance was based on an alpha level of ≤ .05.

During the pre-analysis phase, the data were cleaned and assessed for accuracy. All variables were examined to assess for accuracy, missing values, and outliers using frequency distributions, and measures of central tendency. Missing data was managed using pairwise deletion. The data were examined for univariate and multivariate outliers. Box plots were assessed to identify univariate outliers. Normality was assessed using skewness and kurtosis. Linearity and homoscedasticity between variables were assessed using bivariate scatterplots. Finally, variables were assessed for multicollinearity by examining the tolerance statistics.

RMEI frequency counts of errors were determined from category definitions by the instrument: (1) none = 0, (2) once = 1, (3) 2 to 5 times = 3 and more than 5 times = 6 and then summed. TIPI items 2, 4, 6, 8 and 10 were reverse coded, and averages of the two items were calculated to measure the five personality traits.

The sample was examined using descriptive statistics. Frequency distributions, standard deviations, and percentages were examined for all variables. The median was examined in all interval, ratio and ordinal variables due to the skewed nature of the data.

The mode was examined for nominal variables. Pearson's product movement correlation was performed to evaluate bivariate relationships between the dependent variable (RMEI) and continuous independent variables. Spearman's rank correlation and Kruskal-Wallis one-way analysis of variance were performed to examine the relationship between RMEI and categorical independent variables.

Based on the data collected, the need for reorganization of data was completed as follows. Age was collected as a continuous variable. Upon examining the distribution of the data collected for this variable, the following categories were created: (a) 20-29, 30-39, (b) 40-49, (c) 50-59, and (d) ≥ 60. Education was collected as a categorical variable. Upon examining the distribution of the data collected for this variable, it was noted that three participants identified as diploma and two participants identified as doctoral. Therefore, the following three categories were created: (a) Associate/Diploma, (b) Baccalaureate, and (c) Master/Doctoral. Hospital and specialty tenure were collected as continuous variables. Upon examining the distribution of the data collected for this variable, the following three categories were created: (a) 1-10, (b) 11-20, and (c) ≥ 21. Data on personality traits were collected using a 7-point Likert scale. Upon examining the distribution of the data collected for this variable, the following three categories were created: (a) low = disagree strongly, disagree moderately and disagree a little, (b) mid = neither agree nor disagree, and (c) high = agree a little, agree moderately, and agree strongly. To measure workload, participants were asked to report their average nurse to patient ratio ranging between 1:1 and 1:10. Medical-surgical nurses are typically assigned between five and seven patients per shift (AMSN, 2015). Due to the lack of guidance in the literature on how to categorize this variable, the researcher chose to create the following categories: (a) 1:4 or less, (b) 1:5, and (c) 1:6 or more.

Demographic variables collected included sex, role, shift length, work schedule, employment status, and hospital type. Data on hospital size was collected by asking participants to indicate the size of their hospital as less than 50 beds, 50 to 250 beds, and more than 250 beds. Upon examining the distribution of the data collected for this variable, the following two categories were created: (a) < 50 beds, (b) ≥ 50 beds.

Research question 1. "For medical-surgical nurses in hospitals, what is the relationship between individual nurse characteristics and recovered medical errors (i.e. age, education, experience, certification, expertise, and personality)?" This question was answered using descriptive statistics and nonparametric statistics. Spearman's rank correlation and Kruskal-Wallis one-way analysis of variance were used to examine relationships between age, hospital tenure, specialty tenure, education, certification, expertise, personality, and the dependent variable.

Research question 2. "For medical-surgical nurses in hospitals, what is the relationship between organizational factors and recovered medical errors (i.e. Magnet designation and workload)?" This question was answered using descriptive statistics and nonparametric statistics. Spearman's rank correlation and Kruskal-Wallis one-way analysis of variance were used to examine relationships between Magnet designation, workload, and recovered medical errors.

Research question 3. “For medical-surgical nurses in hospitals, what nurse characteristics or organizational factors predict recovery of medical errors?” This research question was addressed using a regression model to determine which independent variables were predictors of recovered medical errors (RME). The number of medical errors recovered per nurse (DV) were counted in whole numbers and varied across the independent variables. As such, the purpose of the research question along with the nature of the data was taken into account when selecting the appropriate statistical method. The outcome variable was not dichotomized as such an approach would have resulted in a loss of information and the ability to distinguish among factors that influence error recovery (Owen & Froman, 2005).

The Poisson-based regression techniques are the standard approach in analyzing count data (the number of times an event occurs) (Khan, Ullah, & Nitz, 2011). A Poisson regression is a form of nonlinear regression that uses maximum likelihood (ML) estimation, much like logistic regression. In a Poisson regression model, the mean and variance are equal. The negative binomial model is an alternative to the Poisson model and is used when an overdispersion or excess zeros exist. In this study, the mean and variance of recovered medical errors (RME) were 21.7 and 375 respectively. The variance was 17.9 times larger than the mean providing evidence of overdispersion in the RME data. Further, there were a number of zero observations. Therefore, a negative binomial regression model was used to address the challenge of overdispersion and excess zeros. The ratio variable was categorized into three groupings; (a) 1:4 or less, (b)

1:5, and (c) 1:6 or more. The reference for the binomial regression model was selected using the quartile method. The lowest category was used as the reference.

All independent variables that were moderately associated with RMEI ($p \leq .20$) in bivariate analysis were considered for the regression models. A full model was estimated with all considered variables, and non-significant variables were removed one at a time from the model in a backward stepwise selection, beginning with the independent variable of the least statistical significance. The final model included only independent variables that demonstrated a statistically significant association with RMEI ($p \leq .05$). Again, a negative binomial model was determined to provide the best fit after considering the Akaike information criterion, Bayesian information criterion, and likelihood ratio tests comparing count models. Predictor variables included age, education, specialty tenure, expertise, certification, role, workload, hospital size, extraversion, and emotional stability.

Ethical Considerations

Approval for this study was obtained from the George Mason University Office of Research Subject Protection (Human Subjects Review Board). Internal review board (IRB) approval was obtained from all hospitals participating in this study. Due to the minimal potential for harm, an IRB exemption was received.

The purpose of the study was disclosed to participants in the first page of the online survey instrument. Completion of the survey was considered participant approval.

Participation in the study was voluntary and participants were able to withdraw from the study at any time. No participant harm was expected from the survey completion.

Summary

The study design was descriptive, cross-sectional, and correlational with two instruments. All instruments were determined to be valid and reliable. The data collection took place between October 2014 and January 2015 using an online survey tool. The survey link was emailed to 4000 nurses. Nonparametric statistics, including Spearman rank order correlation and Kruskal-Wallis one-way analysis of variance, as well as negative binomial model regression were used to address the research questions. The next chapter will provide the results of the statistical tests.

CHAPTER FOUR: RESULTS

The previous chapter described the study design and methodology. Chapter four presents the results of this study. Results are presented in four sections; 1) demographics, 2) recovered medical errors, 3) individual nurse characteristics, and 4) organizational factors.

A total of 438 surveys were returned from the 4000 surveys sent out for a response rate of 10.95%. Of the 438 returned surveys, 254 were excluded because participants answered that they were not employed as a medical-surgical nurse. A total of 184 surveys were eligible for analysis to examine the relationship among variables. Twenty-eight surveys did not contain complete RMEI data and were excluded from regression analysis (*n* = 28). During the regression analysis, one outlier was eliminated leaving 155 surveys eligible for regression analysis.

Sample Characteristics

The mean age of nurses participating in this study was 43.64 (*Mdn* 44, *SD* = 11). The majority of nurses participating in the survey were staff nurses (52.2%) permanently employed (83.7%) working day shifts (65.2%). Approximately two-thirds of participants possessed a university degree (63.6%). The majority of participants had ten or fewer years of experience in their current organization (71.2%), and 55.4% of participants had ten or fewer years of experience in their specialty (see Appendix A).

The sample characteristics were examined against the findings of two national nursing workforce surveys. One was a national nursing workforce survey based on licensure data, and the other was a survey of nursing trends and education conducted by the Bureau of Health Professions (Budden, Zhong, Moulton, & Cimiotti, 2013, HRSA, 2013). The mean age of this study sample was slightly younger ($M = 43.64$) than the mean age of the national workforce survey participants ($M = 48$). The federal survey reported the average age of the nursing workforce as 44.6 years. Sampling strategies based on state licensure data have been found to result in an undercount of younger nurses due to lags in the processing of state data that may account for the differences (Auerbach, Staiger, Muench, Buerhaus, 2012). The education characteristics of this study sample, in general, were similar to those of the two national surveys (Budden, et al., 2013, HRSA, 2013).

Cronbach's Alpha for Instruments

Cronbach's alpha was calculated to examine the internal consistency of the RMEI and TIPI. Cronbach's alpha for the REMI subscales ranged from .80 (Poor Judgment subscale) to .94 (Mistake subscale). The RMEI instrument had an overall internal consistency of .94 in this study.

The Cronbach's alpha for the TIPI domains ranged from .58 to .25 (.58 for Extraversion, .36 for Agreeableness, .25 for Consciousness, .47 for Emotional Stability, and .31 for Openness). Each domain consisted of two questions. The TIPI had an overall internal consistency of .60 in this study.

Recovered Errors

Each participant recovered, on average, 22 medical errors during the three-month study period (*M* = 21.74), and a total of 3,392 errors were recovered during this time. The following five reasons accounted for slightly more than 50% of the recovered medical errors: (1) mismanaged aversive symptoms, (2) absent or missed a physical exam, (3) mismanaged coexisting health issues, (4) missed orders for prophylactic measures, and (5) improper precaution technique.

Individual Nurse Characteristics

When examining the relationship between recovered medical errors and individual characteristics, the number of recovered medical errors was significantly higher with increasing education ($r_s = 0.309$, $p \leq 0.001$), and expertise ($r_s = 0.235$, $p = 0.003$). Baccalaureate level nurses were estimated to have a 1.5 times ($p = 0.016$) higher medical error recovery rate, and masters and doctoral level nurses were estimated to have a 1.9 times ($p = 0.005$) higher medical error recovery rate as compared to associate or diploma trained nurses. Expert nurses were estimated to have 4.1 times ($p = 0.000$) the medical error recovery rate of novice nurses. No significant relationships were found between age, hospital tenure, specialty tenure, certification, and personality.

Organizational Characteristics

Regarding relationships between organizational factors and the dependent variable, there was a moderate inverse relationship between the patient ratio ($r_s = -0.280$, $p \leq 0.001$) and recovered medical errors. Nurses working in hospitals with more than 50 beds were estimated to have 2.3 times (p = 0.016) the medical error recovery rate than those working in small hospitals (< 50 beds). No significant relationships were found between Magnet designation and recovered medical errors.

In this chapter, results of the quantitative analysis were presented for the three research questions. In summary, each medical-surgical nurse recovered, on average, 22 medical errors during a three-month period. The regression model indicated that three factors significantly influenced medical error recovery; education (p = 0.001), expertise (p = 0.003), and hospital size (p = 0.016). Chapter five presents a discussion of the results as well as conclusions and recommendations for future research.

CHAPTER FIVE: DISCUSSION

This chapter highlights the major findings from this study. This chapter also addresses the study limitations and concludes with implications for future research.

Discussion

The results of this study demonstrate the important role of medical-surgical nurses in patient safety. Medical-surgical nurses today are caring for larger numbers of patients age 65 and older with multiple comorbidities (American Hospital Association, 2012). The empirical literature indicates that preventable medical errors occur more frequently in older hospitalized patients (de Vries et al., 2008). Thus, medical-surgical nurses are caring for patients who, by definition, are at higher risk for medical errors (Considine & Botti, 2004).

Over the course of three months, medical-surgical nurses in this study recovered a total of 3,392 medical errors that could have resulted in patient harm. If these findings were extrapolated to twelve months, a total of 13,568 medical errors could be prevented each year.

Assessment and ongoing surveillance are a primary nursing function. Nurses maintain the responsibility for initiation of interventions in the face of clinical deterioration and initiate actions to correct potentially harmful situations in response to patient or environmental assessments. Mismanagement of aversive symptoms, missed or absent physical examinations and mismanaged coexisting health issues were the most frequently recovered medical errors in this study. These findings were similar to the findings of Dykes, Rothschild, and Hurley's (2010) study of critical care nurses and Flynn's study of recovered medication errors. Nurses play a critical role in surveilling both the patient and the environment, detecting complications, and preventing or mitigating patient harm.

There was a significant relationship between nursing expertise and recovered medical errors. Expert nurses exhibit exceptional clinical reasoning skills consisting of holistic nursing knowledge, skilled know-how and knowledge of the patient (Henneman et al., 2006; Hurley et al., 2008). Further, expert nurses are more likely to recognize patterns and rapidly synthesize information. Medical-surgical nurses who rated themselves as an expert or competent practitioners in this study were more likely to recover medical errors than novice nurses. This finding provides further validity of Benner's (1984) skill acquisition theory and demonstrates that nursing expertise is an important influence in keeping patients safe. As nurses progress through Benner's levels of performance, they may have acquired greater skill-based and patient-based knowledge and sharpened their clinical reasoning skills. The findings from this study add to previous studies that revealed the important role of expertise in medical error (Patel et al., 2011; Wilkinson et al., 2011).

There was a significant relationship between education and recovered medical errors. A growing body of evidence indicates that a higher level of nursing education is associated with better patient outcomes (Aiken et al., 2011; Aiken et al., 2003; Dunton et al., 2007). Research indicates that hospitals with a higher proportion of baccalaureate prepared nurses have lower mortality and failure to rescue rates. This study provides evidence that university-prepared nurses are more likely to recover medical errors than nurses prepared in associate or diploma programs. Thus, the relationship between nursing education and patient outcomes may be partially explained by nurses recovering medical errors and reducing negative consequences.

It is widely accepted that workload is an important influence on patient outcomes (Aiken et al., 2011; Kutney-Lee, Lake, & Aiken, 2009). A study of error handling processes in two Dutch hospitals found that heavy workload negatively impacted nurses' ability to recover medical errors (Habraken & van der Schaaf, 2010). This study indicated there was a modest inverse relationship between recovered medical errors and workload. Given the acuity, complexity, and rapid turnover of patients on medical-surgical units today, nurses with higher patient loads may experience greater cognitive workloads and be less able to provide the vigilance needed to recover errors. Further research is needed in this area.

When a culture of safety is a high organizational priority, staff are continually vigilant in recognizing and resolving safety issues (Rothschild et al., 2005). Further, safe work environments have been associated with higher quality nursing care (Flynn et al., 2012). In this study, Magnet designation and recovered medical errors were not associated. This finding may be due to the notion that Magnet designation was not a specific unit-based measure.

Limitations

There are several limitations to this study that must be considered. Given the sensitive nature of medical errors and the use of self-report instruments, results may be over or under-reported. The RMEI is a complex instrument requiring thought and reasoning that may have contributed to the number of incomplete surveys.

Convenience sampling potentially decreases the generalizability of these study findings. Comparisons between participants and the general nursing workforce revealed similar demographic characteristics and the results are consistent with previous research (Budden, et al., 2013; Dykes, et al., 2010; Wilkinson, et al., 2011). The correlational nature of the study focused on associative relationships and did not allow for making inferences regarding the causality of variables.

Regarding the low return rate, nurses may have chosen not to participate in this study for several reasons. First, while the notion of near misses is well known in the profession, the phenomenon of recovered medical errors is relatively new and not well understood. Thus, being unfamiliar with the term, nurses, may not have been motivated to participate in the study. Second, nurses are frequently asked to complete surveys that may lead to their participating in only the most relevant surveys. Nurses recruited from the health care system were younger and held an associate degree in nursing (58%).

Again, non-university educated nurses may not have associated recovered medical errors with an important nursing function and chosen not to participate in the study. Additionally, nurses recruited from the professional nurses association were older (46% ≥ 50 years of age) and may not have met the study criteria of currently providing direct care in a hospital. Further, medical-surgical nursing is practiced in a variety of settings, yet many nurses identify with their practice setting such as home health or ambulatory, or patient population such as pediatrics rather than the specialty. Again, these nurses may not have chosen to participate in the study.

Implications for Future Research

Given the growing importance of patient safety within the health care system, it is essential that research continues not only on error prevention but error recovery. With the high cost of errors and the desire to improve patient safety, examining the medical error recovery process among nurses and other health care providers contributes to the patient safety knowledge base. To date, medical error recovery has been viewed more like a spontaneous process and briefly mentioned within the broader context of patient safety. Although nurses' role in error recovery is gaining recognition, studies to date have been exploratory in nature. While this study adds to the knowledge base, there remains a paucity of information regarding positive and negative influences of recovered medical errors.

Conclusion

Creating a safer health care system will depend on the ability of nurses to identify, interrupt, and correct medical errors; thus, preventing patient harm. The findings from this study have made a contribution to the current knowledge base on patient safety. Findings from this study indicate that individual nurse characteristics (education and expertise) have a modest but significant effect on nurses' ability to recover medical errors. Greater understanding of individual nurse characteristics and organizational factors that influence error recovery can foster the development of strategies by administrators and educators to detect and correct medical errors; thus enabling organizations to reduce negative outcomes. Additionally, greater knowledge related to error recovery processes can inform educational strategies to enhance error recovery skills among nurses.

APPENDIX A

Table 1.

Sample Demographics

Variable	No.	%
Sex		
Male	15	8.2
Female	168	91.3
Employment		
Fulltime	154	83.7
Part time	15	8.2
Per diem	15	8.2
Role		
Staff nurse	96	52.2
Charge nurse	49	26.6
Manager	35	19.0
Shift		
Day	120	65.2
Night/Evening	61	33.2
Hours		
8 hour	43	23.4
12 hour	138	75.0
Hospital Size		
Less than 50 beds	10	5.4
50 beds and greater	161	87.5
Teaching Hospital		
Yes	109	59.2
No	62	33.7

Note. $N = 184$

Table 2.

Sample Individual and Organizational Characteristics

Variable	No. (%)	*M (Mdn)*	*SD*
Age (in years)		43.64 (44)	11.19
20 to 29	22 (12.0)		
30 to 39	44 (23.9)		
40 to 49	54 (29.3)		
50 to 59	45 (24.5)		
60 and above	15 (8.2)		
Education			
Diploma	3 (1.6)		
Associate	64 (34.8)		
Baccalaureate	82 (44.6)		
Master	33 (17.9)		
Doctor	2 (1.1)		
Facility tenure (in years)		8.20 (6)	8.03
1 to 10	131 (71.2)		
11 to 20	38 (20.7)		
21 and above	15 (8.2)		
Specialty tenure (in years)		12.61 (10)	10.80
1 to 10	102 (55.4)		
11 to 20	42 (22.8)		
21 and above	26 (14.1)		
Certified			
Yes	76 (41.3)		
No	108 (58.7)		
Perceived expertise			
Novice	9 (4.9)		
Competent	91 (49.5)		
Expert	82 (44.6)		
Magnet			
Yes	65 (35.3)		
No	115 (62.5)		
Patient Ratio			
≤ 1:4	51 (27.7)		
1:5	68 (37.0)		
≥ 1:6	63 (34.2)		

Note. $N = 184$

Table 3.

Association of Nurse Characteristics with the Dependent Variable

Variable	Kruskal-Wallis *p*-value	Spearman Rank *p*-value
Age	0.110	0.404
Education	$\leq 0.001^*$	$\leq 0.001^*$
Hospital tenure	0.847	0.870
Specialty tenure	0.831	0.731
Certified	0.064	0.064
Perceived expertise	0.003^*	0.003^*
Personality		
Extraversion	0.067	0.181
Agreeableness	0.351	0.710
Conscientiousness	0.084	0.840
Emotional stability	0.105	0.464
Open to new experiences	0.853	0.789

Note. $N = 184$, $^*p \leq 0.01$

Table 4.

Association of Nurse Characteristics and Organizational Factors with the Dependent Variable

Variable	Kruskal-Wallis *p*-value	Spearman Rank *p*-value
Magnet designation	0.472	0.292
Nurse/Patient Ratio	$\leq 0.001^*$	$\leq 0.001^*$

Note: $N = 184$, $^*p \leq 0.01$

Table 5.

Negative Binomial Regression Output

Variables	Incident Rate Ratio	95% Confidence Interval		Standard Error	*z*	*p*-value
Education						
Diploma/Associate	[ref]					
Baccalaureate	1.50	1.0766	2.0853	.2527	2.40	0.016*
Master/Doctorate	1.88	1.2070	2.9426	.4284	2.79	0.005*
Perceived Expertise						
Novice	[ref]					
Competent	3.01	1.3892	6.5335	1.190	2.79	0.005*
Expert	4.14	1.8782	9.1138	1.667	3.52	0.000*
Hospital Size						
<50 beds	[ref]					
≥ 50 beds	2.26	1.1656	4.395	.7663	2.41	0.016*

Note: $N = 155$, $^{*}p \leq .05$

APPENDIX B

Survey: Enhancing Patient Safety: Recovery of Medical Errors by Nurses

2 SECTION 1 To begin this survey, it will be helpful to have some general information about you. All information will remain confidential and results will be reported in aggregate only. Please answer the following questions.

3 Are you a medical-surgical registered nurse currently practicing in a hospital?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To How many years have you been actively...

4 How many years have you been actively practicing nursing in this specialty area?

5 How many years have you been employed at your hospital?

6 What is your highest level of nursing education completed?

- ❍ Diploma (1)
- ❍ Associate degree (2)
- ❍ Baccalaureate degree (3)
- ❍ Master's degree (4)
- ❍ Doctorate (PhD/DNP) (5)

7 Are you certified in a nursing specialty area?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To Please describe your level of nursing...

8 In what specialty are you currently certified?

- ❍ Medical-surgical (1)
- ❍ Gerontology (2)
- ❍ Oncology (3)
- ❍ Cardiac Vascular (4)
- ❍ Progressive Care (5)
- ❍ Diabetes Educator (6)
- ❍ Gastroenterology (7)
- ❍ Nephrology (8)
- ❍ Neuroscience (9)
- ❍ Wound Ostomy (10)
- ❍ Other (11)

9 How would you classify your level of nursing expertise? (Please select only one)

- ❍ Novice (1)
- ❍ Competent (2)
- ❍ Expert (3)

10 Is your hospital designated as a Magnet facility?

- ❍ Yes (1)
- ❍ No (2)

If Yes Is Selected, Then Skip To What is your gender?

11 Is your hospital on the Magnet journey?

- ❍ Yes (1)
- ❍ No (2)

12 What is your gender?

- ❍ Male (1)
- ❍ Female (2)

13 What is your age?

14 How would you classify your employment status? (Please select only one)

- ❍ Full-time (1)
- ❍ Part-time (2)
- ❍ Per diem (3)

15 How would you classify your role on the nursing unit? (Please select only one)

- ❍ Staff nurse (1)
- ❍ Charge nurse (2)
- ❍ Manager (3)

16 What shift do you typically work?

- ❍ Day (1)
- ❍ Night (2)
- ❍ Evening (3)

17 What is the typical length of your shift?

- ❍ 4 hours (1)
- ❍ 8 hours (2)
- ❍ 12hours (3)

18 What is your typical nurse to patient ratio ?

- 1:1 (1)
- 1:2 (2)
- 1:3 (3)
- 1:4 (4)
- 1:5 (5)
- 1:6 (6)
- 1:7 (7)
- 1:8 (8)
- 1:9 (9)
- 1:10 (10)

R1 SECTION 2 As you reflectively think back about your nursing practice over the past 3 months, please indicate how many times you identified, interrupted, or corrected the following errors and prevented patient harm.

R2 A necessary order for radiographic study or other diagnostic test was delayed for no clinical reason; e.g. position was not verified after a new endotracheal tube was placed during cardiac arrest or a new central line after a difficult insertion.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R3 A malfunctioning therapeutic device was not correctly diagnosed; e.g. a misplaced chest tube; cardiac wire causing ventricular irritability; pacemaker not working properly.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R4 Clinical signs indicative of an emergent problem were not detected or incorrectly interpreted; e.g. ventricular tachycardia developed during a pulmonary artery line insertion was not recognized; need to adjust a line that was in wedge or floating.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R5 An improper volume of intravenous fluids was ordered without taking the patient's current clinical condition into consideration; e.g. co-existing chronic renal failure or congestive heart failure.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R6 A clearly necessary prophylactic measure to prevent predictable complications or manage side effect profiles of therapy was not ordered; e.g. patient at very high-risk for DVT or gastric bleeding.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R7 Clinically indicated medications for managing aversive symptoms were not initiated or the dose was insufficient to provide relief; e.g. inadequate treatment of pain or anxiety.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R8 A protocol was rigidly followed instead of adjusting medications or doses according to the patient's clinical signs; e.g. to diurese a petite elderly patient or to extubate a fully sedated patient.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R9 Co-existing health issues were improperly addressed; e.g. long-standing and necessary psychiatric medications were not reordered or an unnecessary delay in ordering nutrition for a cachectic patient.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ Once (4)

R10 Physical examination of the patient was absent or incomplete; e.g. not turning the patient or looking at the back to check for edema; intubating a patient without removing dentures.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R11 Vital signs were interpreted incorrectly in guiding a treatment decision; e.g. not recognizing potential danger in a set of slowly changing vital signs; not interpreting changing clinical signs in the context of a potentially developing cardiac complication; not considering the therapeutics required to support vital signs when determining the patient's status.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R12 EKG monitoring strips were improperly used in evaluating a change in clinical status/evolving complication; e.g. not reviewing the entire 24-hour monitoring strips or not reviewing the correct strips.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R13 Laboratory data were not adequately considered to guide a treatment decision; e.g. missing a rapid change in a laboratory value; not reviewing recent laboratory values before ordering a medication contingent upon that specific test result; not noticing an abnormal laboratory value that should have signaled the need for an immediate intervention.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R14 Medical record data were not reviewed to learn background information or recommendations about a patient's treatment plan; e.g. not reading consultant's suggestions or not knowing of a condition listed in the medical record that would contraindicate giving a typical medication used for presenting symptoms.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R15 Adequate precaution technique was not carried out for a compromised patient or during invasive procedures; e.g. failing to wash hands, use a mask, or use sterile technique when indicated; wearing latex gloves or not washing latex off hands before doing a procedure on a patient with a latex allergy.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R16 A medication was incorrect because it was ordered to be given to the wrong patient; e.g. an order was written on the wrong chart or computer screen.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R17 A medication was incorrect because it was ordered to be given to the wrong patient; e.g. an order was written on the wrong chart or computer screen.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R18 A medication order was wrong because it was contraindicated for the patient; e.g. an incorrect medication given the patient's clinical signs; a patient especially sensitive to a certain medication required a lower dose; a medication allergy should have precluded ordering that drug or mandated use of supplies free of that drug (such as a heparin free line).

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R19 A medication order was wrong because it was not discontinued; e.g. a potent medication was no longer clinically required; a medication could exacerbate an acute co-morbid condition; a medication was contraindicated because the patient's clinical condition changed.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R20 A medication order was wrong because it did not include necessary parameters for titrating, withholding or adjusting doses; e.g. not titrated to accommodate a patient's size; did not account for the patient's acute renal failure; adjustment was delayed when the need was clearly indicated by laboratory values.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R21 A medication order was wrong because it was omitted; e.g. an alternative medication to facilitate weaning from a potent drug; a new medication to be initiated as stated during rounds.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R22 A medication order was wrong because the wrong dose was ordered.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

R23 Electrolyte replacement was not ordered correctly.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R24 Inadequate technique for performing an invasive procedure at the bedside were used; e.g. removing an arterial line used for invasive monitoring without having a blood pressure cuff in place for non-invasive monitoring; not having a nurse present to provide necessary assistance; removing a central line without considering if medications needed to be administered through that line; not discontinuing heparin before doing a non-emergency invasive procedure.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R25 The risk of potential complications was unnecessarily increased during bedside procedures; e.g. by repeating invasive procedures that may not have been necessary; using pressure that could prompt a vagal response without monitoring; making multiple attempts at central line insertion and placing the patient at risk for pneumothorax.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R26 The timing of invasive monitoring or therapeutics was improper given the patient's condition; e.g. remaining on a balloon pump beyond clinical necessity; "wait until morning" or "after rounds" for a central line to administer needed medications; delay in inserting a temporary wire considered necessary to alleviate an arrhythmia.

- ❍ None (1)
- ❍ Once (2)
- ❍ 2 to 5 times (3)
- ❍ More than 5 times (4)

R27 A decision to transfer a patient to an environment lacking clinically required expertise was considered unsafe; e.g. an unstable patient from the CCU to a medical unit; not scheduling a patient for the surgical ICU after complicated surgery; ordering diagnostic testing to be done at a remote site.

- None (1)
- Once (2)
- 2 to 5 times (3)
- More than 5 times (4)

Q70 Here are a number of personality traits that may or may not apply to you. Please indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

	Disagree strongly (1)	Disagree moderately (2)	Disagree a little (3)	Neither agree nor disagree (4)	Agree a little (5)	Agree moderately (6)	Agree strongly (7)
Extraverted, enthusiastic (1)	❍	❍	❍	❍	❍	❍	❍
Critical, quarrelsome. (2)	❍	❍	❍	❍	❍	❍	❍
Dependable, self-disciplined (3)	❍	❍	❍	❍	❍	❍	❍
Anxious, easily upset. (4)	❍	❍	❍	❍	❍	❍	❍
Open to new experiences, complex. (5)	❍	❍	❍	❍	❍	❍	❍
Reserved, quiet. (6)	❍	❍	❍	❍	❍	❍	❍
Sympathetic, warm. (7)	❍	❍	❍	❍	❍	❍	❍
Disorganized, careless. (8)	❍	❍	❍	❍	❍	❍	❍
Calm, emotionally stable. (9)	❍	❍	❍	❍	❍	❍	❍
Conventional, uncreative. (10)	❍	❍	❍	❍	❍	❍	❍

20 Please indicate if your hospital a teaching facility. (Select only one)

- ❍ Yes (1)
- ❍ No (2)

21 Please indicate the size of your hospital. (Select only one)

- ❍ less than 50 beds (1)
- ❍ 50 to 250 beds (2)
- ❍ more than 250 bed (3)

Q71 Are there any aspects of your work environment, personnel, or unit leadership that could be changed to improve or promote error recovery? If so, please describe.

22 OPTIONAL: Thank you for completing this survey. Your participation in this study is important. Be sure to include your email address in order to be entered to win one of four $25 Amazon gift cards that will be presented to randomly selected participants.

Q69 Thank you for completing this survey!

Office of Research Integrity and Assurance

Research Hall, 4400 Univeristy Drive, MS 6D5, Fairfax, Virginia 22030
Phone: 703-993-5445; Fax: 703-993-9590

DATE:	August 26, 2014
TO:	Barbara Hatcher, PhD, RN, FAAN
FROM:	George Mason University IRB
Project Title:	[630604-1] ENHANCING PATIENT SAFETY: EXAMINING FACTORS ASSOCIATED WITH RECOVERY OF MEDICAL ERRORS BY MEDICAL-SURGICAL NURSES
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	August 26, 2014
REVIEW CATEGORY:	Exemption category #2

Thank you for your submission of New Project materials for this project. The Office of Research Integrity & Assurance (ORIA) has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

Please remember that all research must be conducted as described in the submitted materials.

Please note that any revision to previously approved materials must be submitted to the ORIA prior to initiation. Please use the appropriate revision forms for this procedure.

If you have any questions, please contact Karen Motsinger at 703-993-4208 or kmotsing@gmu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within George Mason University IRB's records.

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