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The Contributing Factors to Student Nurse Medication Administration Errors and Near Misses in the Clinical Setting as Identified By Clinical Instructors

Kristen M. Selig
University of Wisconsin-Milwaukee

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by

Kristen M. Selig

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ABSTRACT

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Kristen M. Selig

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The report, *To Err is Human,* by the Institutes of Medicine (IOM, 2000) brought attention to medication safety in the United States healthcare system. While advances have been made in patient safety, including electronic medication dispensing systems, electronic medication administration records, and scanning systems, it is estimated that 7,000 to 9,000 people die each year due to medication errors (Tariq et al., 2019). The medication administration process involves steps from prescribing to administration. However, nurses administering the medications are the final check point. James Reasons' *Swiss Cheese Model of Accident Causation* illustrates the role that systems play in medical errors. The purpose of this dissertation is to determine the factors that contribute to undergraduate, prelicensure student nurse medication errors and near misses as identified by clinical instructors and the interventions that may help to mitigate these factors. The top 5 most common contributing factors of medication errors and near misses were 'students having limited knowledge about medications,' 'the names of many medications are similar.' 'all medications for one team of patients cannot be passed within an accepted time frame,' 'the packaging of many medications is similar,' and 'students do not receive enough instruction on medications.' The results have implications in nursing education and the potential to impact patient safety.

I could not have completed this journey without the support of my husband, Jim. His patience and unending support allowed me the time to focus on my work. To my sons Alex and Andrew, who I love dearly and who never once complained about my being in school much of their childhood. A special thank you to my daughter-in-law Rita who was one of my biggest cheerleaders and always asked about my progress. To my parents Bernie and Claudia McCaffery, who taught me the value of hard work. To my sister and brother-in-law Kim and Wade Kuipers, who have often asked about my project, and then spent much time listening to me ramble. To my amazing coworkers, who cheered me on through this whole process. Last but not least, to Suzanne Mullis, who joined me on this journey five years ago. Without her, I would not have survived.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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CHAPTER 1

INTRODUCTION

This program of research is aimed at examining the contributing factors to medication administration errors and near-misses by undergraduate pre-licensure nursing students as perceived by clinical instructors.

Statement of the Problem

In 2000 the IOM report, *To Err is Human* raised awareness of medication safety in the United States healthcare system. At least 25% of all medication errors are preventable (IOM, 2007). The most frequent occurrences are during the prescribing and administration stages (IOM, 2007). Nurses are responsible for the administration stage, which includes administering medications and monitoring for effectiveness and side effects. At the point of administration there is no other professional to intervene before the administration of medications and reports have suggested that nurses are responsible for up to 38% of medication errors (Bates, 2007). Further, 49% to 53% of novice nurses are involved in errors of nursing care (Smith & Crawford, 2003; Kenward & Zhong, 2006). Although medication administration involves many steps, including prescribing and dispensing, it is the administration phase that puts nurses at the sharp end of a medication error. It is the final check-point for ensuring safe medication administration. Medication administration errors can be viewed in two distinct ways. One approach is the system approach (Reason, 2000). According to this model, errors are to be expected as part of a system that is made up of humans that are fallible (Reason, 2000). The second approach is that of the person approach. This approach focuses on the unsafe acts of the person at the sharp end, or the nurse administering the medication (Reason, 2000).

While the majority of research regarding medication errors at the point of administration focuses on registered nurses, student nurses have been identified as well (Harding & Petrick, 2008; Hess et al., 2016; Reid-Searl & Happell, 2011; Wolf et al., 2006). Nursing students must function as learners in the clinical setting and be under the direct supervision of their clinical instructors or preceptors during the medication administration process. According to Perry & Koharchik (2014), administration errors should not be occurring in this context.

Factors contributing to student nurse medication administration errors have been identified in the literature and include human factors such as knowledge deficits and inexperience (Deans, 2005; Fry & Dacey, 2007; Harding & Petrick, 2008; Sears et al., 2013; Treiber & Jones, 2012; Wolf et al., 2006) as well as factors within the organization such as busyness and distractions (Deans, 2005; Fry & Dacey, 2007; Harding & Petrick, 2008; Johnson et al., 2017; Jones & Treiber, 2010; Sears et al., 2013; Smeulers et al., 2014; Treiber & Jones, 2012; Wolf et al., 2006). There is a paucity of literature from the clinical instructor's perspective on the contributing factors to nursing student medication administration errors and near-misses.

In 2008 the National Council State Boards of Nursing (NCSBN) (National Council State Boards of Nursing, 2009) convened an invitational roundtable to discuss the future of nursing education. Following the roundtable discussion, NCSBN formed the Innovations in Education Regulation Committee to review the literature and investigate innovative approaches to nursing education and the barriers that hinder them (Spector & Odom, 2012). The outcome was a recommendation that nursing educators address the increasing complexity of healthcare by altering nursing curriculum. However, the committee also recognized that without communication and collaboration among the practice partners, regulators, and educators,

invention and adoption of innovative approaches could not occur (Spector & Odom, 2012). While some changes have occurred, such as the increased use of simulation, it is clear there is more work to be done. Advances have been made in patient safety, specifically medication safety. Computerized provider order entry (CPOE), electronic medication administration record (eMAR), barcoding systems, and automated dispensing cabinets are all examples of innovative advancing technology designed to increase medication safety. However, all these systems are only as good as the operator. Van der Veen et al. (2018) found a significant association between workarounds and medication errors, indicating that nurses did not use the technology as intended, increasing the risk for medication administration errors, regardless of the technology in place to prevent them. Reliance on technology may lead to nurses ignoring the basics of medication administration such as the five rights; right drug, right patient, right dose, right route, and right time (Hidle, 2007). It is essential to identify the contributing factors to student nurse medication administration errors and near-misses in the clinical setting as identified by clinical instructors.

Population of Concern and Prevalence

The population of interest is the clinical instructors of undergraduate nursing students. The role of the clinical instructor is to bridge the gap between theory and practice (Akram et al., 2018). The supervision of medication administration is an essential responsibility for clinical instructors. Since nursing students are supervised during this process, the risk of error is minimal. It is expected that students will make near-misses during the medication administration process. These near-miss events should be used as an opportunity to learn and prevent future errors. Analysis of near-miss errors can yield information regarding contributing factors and is

vital to the improvement of system processes and the supervision of nursing students, and possibly the revision of the nursing curriculum (Committee on Data Standards for Patient Safety, 2004).

Sequelae

Preventable medical errors can exact significant tolls, including the loss of human life. In the United States, it is estimated that 7,000 to 9,000 people die each year as a result of medication errors (Tariq et al., 2019). The IOM report "To Err is Human" was the first estimate of medical errors that received widespread attention. However, in a literature review conducted by James (2013), four studies were identified that utilized the Global Trigger Tool (GTT). This tool uses triggers, or tools, to identify adverse events, while traditional efforts use voluntary-reporting (Institute for Healthcare Improvement, 2020). James used a weighted average of the four identified studies to determine the lower-limit of deaths per year to be 210,000 (2013). This statistic does not account for the limitations in the search capability of the tool and the incompleteness of the medical records on which the tool depends. Taking this into account, it is estimated that the true number of premature deaths per year associated with preventable harm is more than 400,000 (James, 2013).

Medication errors are costly in terms of increasing a patient's length of stay, increased use of resources, patient harm, and the potential of lost life (Schelbred & Nord, 2007). Medication errors can also exact significant tolls on the nurses. Treiber and Jones (2018) found that emotions ranged from fear, guilt, anger, shame, and disappointment and that nurses used the descriptors of "horrible," "terrible," and "awful" to describe the incident.

Gap Analysis

There is a paucity of literature in nursing education focusing on the contributing factors of medication administration errors and near-misses in undergraduate nursing students. There is a substantial amount of literature that focuses on mathematical calculations; however, the literature does not support this as a major contributing factor. The literature has also focused on the analysis of medication administration errors committed by nurses (Asensi-Vicente et al., 2018). While there may be similarities in medication administration errors of nurses and those of student nurses, nurses have experience. Students have limited experience and are relying on the rules and five rights of medication administration learned in school. Examining the specific contributing factors to medication administration errors and near-misses of students is crucial to address problems within the curriculum or change the curriculum to meet the increasing complexity of healthcare.

There is a paucity of literature that is specific to nursing education and medication administration errors and near-misses. Current evidence suggests that the incidence of medication administration errors and near-misses involving nursing students is high (Asensi-Vicente et al., 2018). While a study conducted by Balas et al. (2006) found that critical care nurses reported more near-misses than actual errors, there are no identified articles that explore them. Since student nurses are most often supervised by clinical instructors, it can be assumed that most potential errors are being captured prior to commission.

Differences in the definitions of medication administration errors and near-misses can cause confusion among nurses as to what constitutes a medication error or a near-miss. According to the National Coordinating Council for Medication Error Reporting and Prevention

(NCCMERP), a medication error is "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer (n.d.). A near-miss is an event, situation, or error that took place but was captured before reaching the patient (Institute for Safe Medication Practices [ISMP], 2009). The confusion between the two definitions can further complicate the evaluation of factors that contribute to medication errors and near-misses (Gladstone, 1995; Baker, 1997; & Mayo & Duncan, 2004). To date, there is no research regarding how undergraduate nursing clinical instructors define a near-miss.

Definitions of Medication Errors and Near-Misses

The definition of medication errors and near-misses varies throughout the literature. A systematic literature review on medication error definitions by Lisby et al. (2010) revealed a multiplicity of terms involved, and it has been suggested that this inconsistency has contributed to variation in the reporting of medication errors. This lack of a clear definition hinders reliable comparison of findings across studies. To clearly understand the current literature, it is important to explore these definitions. Differences in definitions cause confusion among nurses as to what constitutes a medication error or a near-miss. These differences can further complicate the evaluation of factors that contribute to medication errors and near-misses (Ghaleb et al., 2006; Gladstone, 1995; Baker, 1997; Lisby et al., 2010; Maidment et al., 2006; Mayo & Duncan, 2004; Miller et al., 2007).

Barker and McConnell (1962) provide an early definition of medication error:

> The administration of the wrong medication, drug, diagnostic agent, chemical or treatment requiring the use of such agents, to the wrong patient or at the wrong time or

failure to administer such agents at the specified time or in the manner prescribed or normally considered as accepted practice (p.361).

An identified issue with this definition is its identification only of the administration phase, not considering the writing of the original prescription.

Allen and Barker (1990), Cooper (1995), and Mayo and Duncan (2004) all used a similar definition of medication error, which is based upon the American Society of Hospital Pharmacists (ASHP) standard definition “A dose of medication that deviates from the physician’s medication order on the patient’s chart” (ASHP, 1982, p. 321). This definition is also lacking the prescription phase of the medication administration process.

The National Coordinating Council for Medication Error Reporting and Prevention defines medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures, and systems, including prescribing, order communication, product labeling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use" (National Coordinating Council for Medication Error Reporting and Prevention, n.d.) This definition is broad and encompasses disciplines outside of nursing, and has the previous definitions embedded within, and will therefore be utilized in this literature review.

The term near-miss is essential to define as well. Like medication errors, there are several identified definitions of near-miss in the literature. Sheikhtaheri (2014) identified the controversies in the details of the differences. Some definitions emphasize the occurrence before reaching the patient, while others identified a near-miss as an error that reached the patient but

did not cause harm. According to the ISMP, a near-miss is defined as an event, situation, or error that took place but was captured before reaching the patient (ISMP, 2009). Near-misses can provide a wealth of information that can inform error prevention strategies. However, it is assumed that similar to medication errors, near-misses are also grossly under-reported (Williamson, 2009). For the purposes of this research study, the definition used is the one provided by ISMP, which is an event, situation, or error that took place but was captured before reaching the patient.

It is also important to distinguish the term adverse drug event from the term medication error. An adverse drug event is an injury resulting from medical intervention related to a drug and includes both appropriate use and inappropriate use (Bates et al., 1995). It does not necessarily indicate poor quality care or the occurrence of an error (Agency for Healthcare Research and Quality, 2019).

Causative Factors Versus Contributing Factors

It is important to distinguish between causative factors of medication administration errors and contributing factors to medication administration errors. Causative factors of medication errors are those things that cause the error to occur, such as communication, documentation, human factors, etc. Contributing factors differ from causative factors in that they are factors that contribute to medication errors but are not the cause of the error, although in some instances, they may directly generate an error. Contributing factors increase the risk of a medication error, such as not following guidelines or reviewing data (Jylhä et al., 2011).

Categories of medication errors

Like definitions of Medication Errors and Near-Misses, categories of medication errors may also vary within the literature. These differences have implications for measuring the

consistency of study conclusions. The NCCMERP (2001) Index for Categorizing Medication Errors provides several categories for medication errors. The categories define whether an error occurred and its effect on the patient involved. Table 1.1 identifies the categories and classifies them according to the severity of the outcome (NCCMERP, 2001).

Table 1.1

NCCMERP Index for Categorizing Medication Errors

Category	Description	Level	Example	Definitions
A	Circumstances or events that have the capacity to cause error	No Error	Look-alike, sound-alike medications placed near each other in the same drawer in medication dispensing system	**Harm:** Impairment of the physical, emotional, or psychological function or structure of the body and/or pain resulting therefrom.
B	An error occurred but the error did not reach the patient (an "error of omission" does reach the patient)	Error, No Harm	A medication order was placed in the wrong chart and identified as incorrect before administering	**Monitoring:** To observe or record relevant physiological or psychological signs.
C	An error occurred that reached the patient but did not cause the patient harm	Error, No Harm	A patient was administered a medication meant for someone else such as a vitamin or Tylenol	**Intervention:** May include change in therapy or active medical/surgical treatment.
D	An error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to the patient and/or required intervention to preclude harm	Error, No Harm	A patient was administered a beta-blocker intended for another patient. Frequent monitoring was required but did not result in harm	**Intervention Necessary to Sustain Life Includes:** cardiovascular and respiratory support (e.g., CPR, defibrillation, intubation, etc.)

Category	Description	Level	Example	Definitions
E	An error occurred that may have contributed to or resulted in temporary harm to the patient and required intervention	Error, Harm	A patient was administered an increased dose of coumadin that resulted in elevated INR and the administration of Vitamin K	
F	An error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization	Error, Harm	A post-surgical patient receiving hydromorphone via Patient Controlled Analgesia (PCA) received an increased basal rate necessitating intubation	
G	An error occurred that may have contributed to or resulted in permanent patient harm	Error, Harm	Pediatric patient administered vesicant via peripheral IV resulting in permanent damage to surrounding tissues and amputation	
H	An error occurred that required intervention necessary to sustain life	Error, Harm	Treatment of hyperkalemia with renal failure with insulin and failure to administer the prescribed D50 can result in severe hypoglycemia necessitating treatment to sustain life	
I	An error occurred that may have contributed to or resulted in the patient's death	Error, Death	Patient administered epinephrine 1:1000 IVP instead of IM for anaphylactic reaction resulting in a lethal heart arrhythmia	

The NCCMERP also classifies the causes and contributing factors to medication errors (2001). The broad categories for the causes of medication errors are Communication, Name Confusion, Labeling, Human Factors, and Package and Design (NCCMERP, 2001). The contributing factors to medication errors are environmental, situational, or organizational influences that may predispose the occurrence of an error (NCCMERP, 2001).

The Dean and Barber Method is a validated and reliable method of scoring the severity of medication errors (Dean & Barber, 1999). This method does not require knowledge of patient outcomes. Fahmy et al. (2018) compared articles that used the NCCMERP Index for Categorizing Medication Errors with those that used the Dean and Barber Method for assessing the clinical importance of medication errors and found that the scores were only weakly correlated, indicating that comparisons between studies have limitations.

Filling a gap

Medication errors can occur at any point along the medication administration process, from the prescribing phase to the procuring, dispensing, and administration phase. Because nurses are responsible for the administration phase of the medication administration process, this is an area where nursing education can directly impact patient safety. Medication errors committed by nursing students are more prevalent than previously thought (Wolf et al., 2009; Wolf et al., 2006). Although education on the medication rights and safe practices of administration begins early in the education of students, it remains a difficult task to master, and students remain susceptible to committing errors (Schneidereith, 2014; Zahara-Such, 2013).

Purpose

The purpose of this study is to investigate undergraduate nursing clinical instructor perceptions of the factors that contribute to nursing student's medication administration errors and near-misses.

Research Questions

Question 1

What are the factors that undergraduate nursing clinical instructors perceive as contributing factors to students administering medications safely?

Question 2

How do clinical instructors describe the factors identified as contributing to medication errors?

Question 3

Do the factors identified by the undergraduate nursing clinical instructors differ by level of student taught?

Hypothesis

There is a statistically significant difference in clinical instructor perceptions of contributing factors to undergraduate nursing students' medication errors and near-misses based on level of student taught.

Question 4

Do undergraduate nursing clinical instructors report differences in frequency of medication errors and near-misses based upon level of student taught?

Hypothesis. There is a statistically significant difference in the number of medication errors and near-misses reported by undergraduate nursing clinical instructors based upon level of student taught.

Question 5

What teaching strategies are most used to teach safe medication administration?

Question 6

What activities and equipment are most frequently used to teach safe medication administration?

Question 7

What activities do undergraduate clinical instructors identify that would improve nursing student medication management?

Model

James Reasons' *Human Error Theory*

The IOM used James Reasons' definition of error in the seminal report *To Err is Human* (2000). According to Reason (1990), an error can be defined as "all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency" (p. 9). There are two approaches to human error, the systems approach and the person approach (Reason, 1990). The system approach looks at the system within which the error occurred. The person is one part of the whole system. The person approach focuses on human weaknesses. This blame-oriented approach was the dominant approach for many years. Placing blame on an individual removes the blame from the organization. This approach leads to underreporting and only defeats the development of safer healthcare. Just as Dr. Leape testified before congress in 2000 (Medical Mistakes), A punitive approach will lead to only errors that are unable to be hidden getting reported and valuable information will be lost, and no one will learn from the mistakes that are made.

Reason (1990) insightfully explained that human error is inevitable, especially in complex systems like healthcare, and expecting perfection is unrealistic. The systems approach holds that the system is designed to catch human errors before they occur and is ultimately more realistic.

Reason (1990) proposed two basic error types: slips and lapses versus mistakes. Mistakes are rule-based and knowledge-based mistakes, whereas slips and lapses are skill-based errors and occur with routine activities and in familiar situations (Reason, 1990). A slip or lapse occurs when the action that is conducted is not what was intended and is an error of execution. A slip is not doing what was intended, whereas a lapse is forgetting to do something. In a mistake, the planned action was intended but fails to achieve the intended outcome because the action was wrong.

The *Swiss cheese model of accident causation* illustrates that although there are many layers of defenses in any complex organization such as healthcare, each layer contains flaws and, if aligned just right, can result in an error (Reason, 1990). Reason (1990) described both active and latent failures. An active failure is a failure that occurs at the point of contact between a human and a system, such as a nurse and a patient. A latent failure is a failure of design or a failure of the system. The nurse is at what is considered the sharp end of the failure or error given direct patient contact, whereas the blunt end are those that never came into contact with the patient yet may have contributed to the error through policy, management, or design.

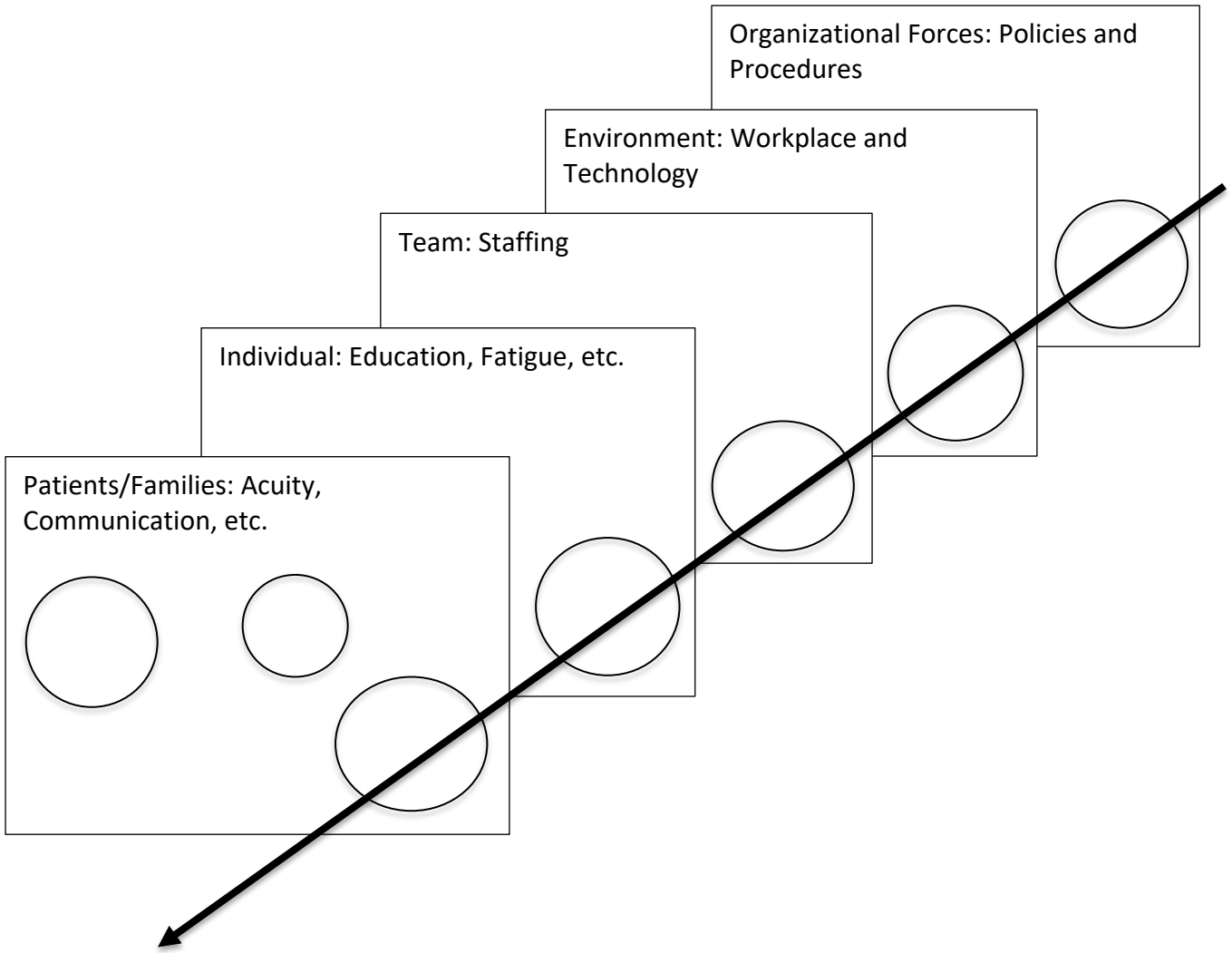
Reason's Swiss Cheese Model of Accident Causation illustrates the conceptualization of accident causation and the interplay of the forces within healthcare that are involved in the accident trajectory (see Figure 1.1). Each slice in the swiss cheese model represents one of the

multiple factors within a healthcare organization that provides a barrier to protect patients from errors. However, each layer contains holes which represent the active failures or latent conditions in the organizational defenses. These layers are dynamic and in continuous flux within the healthcare environment, and, when line up, can result in an accident opportunity.

According to Reason (1990), there is a complex interplay among three forces within an organization that gives rise to errors. These forces are the nature of the task and environment, mechanisms governing performance, and the nature of the individual. In error detection and prevention, understanding these three forces is crucial. The nature of the work and the environment within which it occurs must be identified to establish the conditions under which the error occurred. The mechanisms governing performance, such as the policies and procedures that are in place, help to identify organizational forces that may give rise to errors. Finally, the nature of the individual comprises the cognitive level of the working system. Reason's Model of Accident Causation has been used extensively in healthcare research to explore the concept of error and therefore, will provide the structural framework to examine the factors which contribute to medication errors and near-misses in undergraduate nursing students.

Figure 1.1

Reason's Swiss Cheese Model of Accident Causation



Summary

In summary, Chapter One described the problem of medication administration errors and near-misses as they relate to nursing and nursing students. Chapter Two contains a review of the literature of medication errors and near-misses, including the factors that contribute to them. Chapter Three describes the methods used to investigate the perceptions of clinical instructors of

the contributing factors of nursing student medication errors and near-misses. Chapter Four presents the results of the research. Finally, Chapter Five interprets the results and provides direction for further research.

CHAPTER 2

Manuscript 1: Literature Review of Medication Errors and Near-Misses in Undergraduate Nursing Students and the Factors that Contribute to them

Kristen M. Selig, MS, RN

University of Wisconsin - Milwaukee

Abstract

Introduction: This paper explores medication errors and near-misses and the factors that contribute to them in the literature and identify gaps in current knowledge, specifically regarding undergraduate prelicensure nursing students in associate degree programs and bachelor's degree programs.

Methods: The search terms used included medication error; near-miss; nurs*, student, education; nursing education; perception, attitude; and experience to identify studies relevant to the aim of the review.

Results: A total of 71 articles were identified that were broadly categorized into four themes. The themes identified are barriers to reporting errors, solutions or strategies for reducing the number of errors, medication calculations, and contributing factors of medication administration errors. An additional seven articles investigated students and new graduates and did not fit into one of the previously mentioned categories.

Synthesis and Implications: None of the identified articles include the perspective of the nursing clinical instructor on the factors contributing to student nurse medication administration errors and near-misses. Only five of the identified articles investigated medication errors made by nursing students.

Declaration of Interest: None

Introduction

In 2000 the Institute of Medicine (IOM) published a study entitled *To Err is Human.* This publication was a synthesis of studies that took place over several years in various institutions (IOM, 2000). The conclusion was that the healthcare system is not as safe as it should be (IOM, 2000). It was determined that 2.9 to 3.7% of admitted patients experienced an adverse outcome due to medical intervention (IOM, 2000). It is estimated that among the 33.6 million hospital admissions in the United States (US) every year, 44,000-98,000 deaths are attributable to medical error (IOM, 2000). In addition, the study determined that out of every 131 outpatient deaths, one was attributable to a medication error; and one out of every 854 inpatient deaths was attributable to a medication error (IOM, 2000).

A follow-up study published in 2007 identified a lack of heterogeneity of reported errors due to a variety of sourcing data, which included direct observation, chart review, computerized monitoring, and self-report (IOM). Considering this, the authors concluded that a hospital inpatient is likely to experience one medication error per day (IOM, 2007).

A more recent literature review conducted in 2013 by James reviewed four studies that utilized the Global Trigger Tool (GTT). This tool uses triggers, or tools, to identify adverse events, while traditional efforts use voluntary-reporting (Institute for Healthcare Improvement, 2020). James used a weighted average of the four identified studies to determine the lower-limit of deaths per year to be 210,000 (2013). This statistic does not account for the limitations in the search capability of the tool and the incompleteness of the medical records on which the tool depends. Taking this into account, it is estimated that the true number of premature deaths per year associated with preventable harm is more than 400,000 (James, 2013).

Despite increased attention on patient safety and medication administration safety and error reduction efforts, including process and technological changes, errors continue to remain a serious safety problem (Agency for Healthcare Research and Quality, 2019).

Background

Medication administration errors can exact a significant toll on both patients and nurses. While it is evident that patients can suffer the consequences of medication administration errors, nurses can too. Nurses involved in a medication error can suffer feelings that range from guilt and fear, to loss of self-confidence (Gladstone, 1995; Jones & Treiber, 2010). The term "second victim" is used to describe the nurse that suffers consequences as a result of the error (Wu, 2000). Previous research on nurses' perceptions of medication errors has shown that an actual injury does not even need to occur for a nurse to become a second victim (Dekker, 2013).

In the United States, 7,000 to 9,000 people die annually because of medication errors (Tariq et al., 2019). In addition, hundreds of thousands of others experience adverse reactions and other complications because of medication errors. It is estimated that the cost of caring for patients post-error exceeds $40 billion annually. Patients can experience psychological as well as physical symptoms such as pain because of medication errors. The result is also a decrease in patient satisfaction and an overall decrease in trust in the healthcare system (Tariq et al., 2019).

Literature Review Methods

The literature search consisted of CINHAL, MEDLINE, and Pub Med. The search terms used included medication error; near-miss; nurs*, student, education; nursing education; perception, attitude; and experience. Articles meeting the following criteria were included: available in the English language, published in peer-reviewed scholarly journals, and published

between 2005 and 2020. Articles were restricted to 2005 and later to coincide with the commencement of the Quality and Safety Education for Nurses (QSEN).

Literature Review Process

The search resulted in 349 articles, which were screened according to the title and abstract for relevance to the topic. This process reduced the number of articles to 71. The articles were then divided into themes. The themes identified are barriers to reporting errors, solutions or strategies for reducing the number of errors, medication calculations, and contributing factors of medication administration errors. Some articles fit into more than one theme, for example, articles that explored the contributing factors to medication errors as well as the barriers to reporting them. An additional seven articles were identified that investigated students and new graduates that did not fit into one of the previously mentioned categories.

Results

Barriers to Error Reporting

Eleven articles were identified under the theme "barriers to error reporting." Five of the articles are from South Korea (Fathi et al., 2017; Kim et al., 2011; Kim, 2012; Lee et al., 2018; You et al., 2015), one is from Taiwan (Chiang & Pepper, 2006), one is from Saudi Arabia (Al-Otaibi et al., 2018), one from Ethiopia (Bifftu et al., 2016), one from Malta (Petrova et al., 2010), one from Norway (Waaseth et al., 2019), and one from Canada (Covell & Ritchie, 2009). One study was qualitative (Waaseth et al., 2019) and one mixed methods (Covell & Ritchie, 2009). The rest of the studies were all quantitative.

Of the identified articles, six of them used the Medication Administration Error Reporting Questionnaire developed by Wakefield (Bifftu et al., 2016; Chiang & Pepper, 2006; Covell & Ritchie, 2009; Kim, 2012; Petrova et al., 2010; You et al., 2015). Personal,

organizational, and cultural barriers were identified in all the studies. Fear was identified as a significant barrier in multiple studies (Al-Otaibi et al., 2018; Bifftu et al., 2016; Chiang & Pepper, 2006; Covell & Ritchie, 2009; Kim et al., 2011; Kim, 2012; Petrova et al., 2010; You et al., 2015). Articles utilizing the Wakefield developed questionnaire further categorized the fear into subscales. Fear of adverse consequences (Chiang & Pepper, 2006; Covell & Ritchie, 2009) and being blamed (Chiang & Pepper, 2006; Petrova et al., 2010; You et al., 2015) were found to be significant, even in articles that used surveys developed by other authors (Al-Otaibi et al., 2018). Workload, lack of time, and reporting effort were also found to be a barrier (Fathi et al., 2017; Kim, 2012; Waaseth et al., 2019). It was also identified that if the nurse did not feel the error was serious (Lee et al., 2018) or did not agree that time was an error (Bifftu et al., 2016), it was not reported. One interesting finding in an article by Covell and Ritchie (2009) was if the unit's culture was good, and the working relationships were good, errors were not reported.

Lee et al. (2018) conducted a longitudinal study to explore safety climate and the barriers to reporting pre- and post-hospital accreditation. One item that did not improve post-accreditation was the nurse's ability to identify when an error occurs. Post-accreditation fear of their managers' reactions decreased, as did fear of coworker's reactions. None of the identified articles focused on the reporting of medication errors by nursing students or newly graduated students.

Solutions or Strategies for reducing Number of Errors

A total of 22 articles were identified under the theme solutions or strategies for reducing the number of errors. Six of the articles focus on interruptions and distractions (Palese et al., 2019; Pape et al., 2005; Pape et al., 2013; Verweij et al., 2014; Westbrook et al., 2017; Williams et al., 2014). Four of the articles focus on smart intravenous pump systems as they relate to

decreasing medication errors (Bowcutt et al., 2008; Mason et al., 2014; Rosenkoetter et al., 2008; Rothschild et al., 2005). Five articles focused on an education program, such as medication safety (Dennison, 2007; Schneider et al., 2006; Tan et al., 2017), simulation to impact patient safety (Sears et al., 2010), or faculty development to impact student medication administration safety (Perry & Koharchik, 2014). Three articles focus on electronic medication dispensing systems and their relationship to patient safety (Rochais et al., 2014; Smith et al., 2016; Van De Vreede et al., 2017). One article focused on the decentralization of medication distribution to the bedside (Bennett et al., 2006) and two articles focused on the effect of bar code scanning on medication errors (Gooder, 2011; Ulanimo et al., 2007). One article discussed the impact of systems thinking on medication errors (Tetuan et al., 2017). The only articles that focused specifically on students and new graduates were the articles by Perry & Koharchik (2014) and Sears et al. (2010).

Interruptions and Distractions

The aim of the article by Palese et al. (2019), which focused on interruptions and distractions, was to evaluate the patient's perceptions of three different types of tabards worn by nurses administering medications, and not necessarily the effectiveness of the intervention. Tabards are sleeveless garments that can be marked with wording or made of a specific color to indicate the person wearing them is not to be disturbed. Interestingly what was discovered was that the patients felt the tabards were directed at themselves, creating a new problem, which is the risk of patients not reporting or communicating urgent needs for fear of interrupting the nurse.

Verweij et al. (2014) also evaluated the use of tabards on the frequency and type of interruptions. Data was collected before the implementation of the tabards and two weeks and

four months after. During a five day implementation period all nurses were instructed to wear the tabards while preparing and administering medications. Instructions were provided by email, posters, and promotional film. After observing 313 medication administrations following the implementation, it was found that significant reductions occurred in both interruptions and medication administration errors. Four months after implementation, there was a decrease of 75% in interruptions and 66% in medication administration errors.

Pape et al. (2005), Pape et al. (2013), Westbrook et al. (2017), and Williams et al. (2014) all evaluated the effectiveness of a bundle of interventions designed to decrease interruptions and distractions. The bundles included wearing vests or sashes during medication administration (Pape et al., 2013; Westbrook et al., 2017; Williams et a., 2014), no interruption zones (Pape et al., 2013; Williams et al., 2014), signage (Pape et al., 2005; Pape et al., 2013; Westbrook et al., 2017; Williams et al., 2014), and checklists (Pape et al., 2005; Pape et al., 2013).

Pape et al. (2013) observed a control group prior to the intervention and the intervention group after and recorded the number of interruptions and distractions, as well as the time. The control group had 2.25 distractions per medication given, while the intervention group had 0.4 distractions per medication given. Time also decreased from 5.03 minutes per medication to 3.47 minutes per medication, indicating time savings when interruptions are decreased. All categories of interruptions and distractions were decreased for the intervention group.

Pape et al. (2005) also utilized signage as part of a process improvement study to examine the effects of protocols and signage on medication errors. The protocol was based on observations in another study and included the steps of the medication administration process. Once nurses were comfortable with the protocol, the signage was introduced. The most significant reduction in distractions after the signs were implemented was distractions caused by

other nurses. Other personnel, external conversations, and loud noises also decreased; however, physician interruptions did not.

Westbrook et al. (2017) evaluated the effects of a medication vest, interactive workshops, education sessions with clinical staff, and information for patients on interruptions by content, source, and location pre- and post-intervention. Post-intervention nurses on the intervention ward experienced a reduction in interruptions from 56/100 to 38/100 administrations. The control wards experienced little change in rates 59/100 to 57/100.

Williams et al. (2014) also studied the effects of a bundle of interventions, which included nursing staff education, medication safety vest, no-interruption zone, signs, and guidelines for responding to interruptions. Prior to the intervention, 254 distractions and interruptions from all sources were observed. After implementation, 68 were observed, which was a statistically significant decrease. Four types of distractions decreased significantly, including physician distractions or interruptions, nurse receives or places phone call, other personnel distract the nurse, and nurse engages in conversation not related to medication administration or is distracted by a loud conversation in the area.

Smart Intravenous Pump Systems

Three of the articles that focused on IV pumps in relation to safe medication administration found that nurses overall perceived the pumps to increase safe medication administration (Bowcutt et al., 2008; Mason et al., 2014; Rosenkoetter et al., 2008). The article by Rothschild et al. (2005) found no measurable impact on the rate of serious medication errors due to poor compliance.

Education

Of the five articles focusing on an educational intervention to decrease medication error rates, two focused on students. Perry & Koharchik (2014) conducted a series of faculty development sessions designed to increase faculty competency with medication administration supervision and decrease the number of medication errors and near-misses made by nursing students. Results did not indicate an improvement, with total errors increasing from 10 to 17, but 15 were near-misses. It is thought that the faculty development sessions may have led to heightened awareness and attentiveness of faculty to intervene and avert errors.

Sears et al. (2010) studied the use of simulation to reduce medication errors. In a randomized-control group, post-test only design students took part in a simulation during which they were expected to perform medication administration. Following the intervention, the number of incidents reported for the experimental and control groups was compared. The control group had a disproportionately larger share of errors. There were 24 errors in the control group of 30 participants and only seven errors among the treatment group of 24 participants.

The other three articles that evaluated the use of an educational intervention all utilized practicing nurses. The intervention programs were all reasonably similar, with one being two computer-based modules (Dennison, 2007), one being an interactive CD-ROM program (Schneider et al., 2006), and one a video, PowerPoint, and Memory-aid (Tan et al., 2017). Results were mixed with Dennison (2007) showing a statistically significant change in knowledge regarding medication errors. However, there was no change in the climate of safety scores, behaviors advocated in medication safety education programs, number of infusion pump alerts, or number of reported errors. Schneider et al. (2006) showed a significant decrease in CORE 1 errors, which are deviations from following safe medication administration practices.

Core 2 error rates were higher, but not significantly, and include preparation and administration errors. Tan's intervention significantly reduced the error rate from 79% to 50% and improved good practices adherence (2017).

Medication Distribution

Of the six articles focusing on the introduction of technology in the process of medication administration, three focused on the implementation of an electronic medication dispensing unit (Rochais et al., 2014; Smith et al., 2016; Van de Vreede et al., 2017), two articles focused on barcode medication administration (Gooder, 2011; Ulanimo et al., 2007). The articles focusing on electronic medication dispensing systems all found that nurses felt it increased patient safety. Interestingly, Van de Vreede et al. (2017) found that even though 56% agreed or strongly agreed that the system reduced the potential for medication errors, 56% believed that the new errors that were made were a new type of error related to the system itself, such as selecting the wrong patient or incorrect dose scheduling resulting in duplicate doses.

Gooder (2011) and Ulanimo et al. (2007) evaluated medication administration using barcoding. Gooder (2011) evaluated the nurses' satisfaction using a survey and found a decrease in the overall satisfaction with the medication process following the implementation of the barcode medication administration system. Participants felt that the system made it difficult to determine which medication had been administered. Ulanimo et al. (2007) found that all the nurses surveyed agreed that medication errors decreased since implementation of the system.

Bennett et al. (2006) evaluated the decentralization of medication to a locked cupboard at the patient's bedside, instead of a unit dose system with a medication cart. Study results demonstrated that decentralizing medications lead to nurses spending more time with the patients and less time preparing and distributing medication, as well as fewer interruptions.

Systems Thinking

Tetuan et al. (2017) implemented a Systems Thinking Education Program (STEP) to assess the impact on nurse workarounds during medication administration. A total of 1,652 medication passes were observed before the intervention and 1,998 after. The workaround rate decreased significantly from 18.5% to 8.8%, indicating that the STEP program strengthened the nurse's understanding of systems thinking.

Medication Calculations

A total of 10 articles were identified under the theme medication calculations. Six of the articles concerned students and new graduates (Harne-Britner et al., 2006; Hurley, 2017; Mackie & Bruce, 2016; Őzünal et al., 2020; Ramjan et al., 2014; Simonsen et al., 2014). Two of the articles were investigations into the drug calculation skills of nurses (Fleming et al., 2014) and nursing students (Őzünal et al., 2020). Fleming et al. (2014) found that the most frequent errors were conceptual errors, and there were inconsistencies in the amount of pharmacology throughout the curriculum and the skills taught. Rates of correct answers in the study conducted by Őzünal et al. (2020) varied between 20% and 63%. Only 26.4% of the students stated they had sufficient dose calculation skills.

Four of the articles investigated education methods and the impact on medication calculations (Greenfield et al., 2006; Harne-Britner et al., 2006; Hurley, 2017; Sherriff et al., 2012). Greenfield et al. (2006) used a non-randomized quasi-experimental design to determine whether using dimensional analysis as a computation method could reduce calculation errors. Setting the pass rate at 90%, 61.5% passed using the traditional formula method of calculation, while 84.6% of the experimental group passed using dimensional analysis. Harne-Britner et al. (2006) also used a quasi-experimental design to investigate the effects of an educational strategy.

After taking a drug calculation test, participants were given the opportunity to choose among four interventions designed to improve calculation skills. Results demonstrate that both nursing students and practicing nurses had a statistically significant improvement in test scores following the intervention. Hurley (2017) found that an experiential teaching strategy was more effective than the traditional method for teaching medication calculation skills to Baccalaureate nursing students. Sherriff et al. (2012) evaluated the effectiveness of an online medication calculation education and testing program on the skills of practicing nurses and found that test scores following one year of access to the program improved.

Contributing Factors of Medication Administration Errors

Under the theme contributing factors to medication administration errors, 28 articles identified between 2005 and 2020 were written in the English language. Eight of the articles were qualitative (Alharbi et al., 2019; Davis et al., 2005; Härkänen et al., 2018; Musharyanti et al., 2019; Reid-Searl et al., 2008; Sessions et al., 2019; Stetina et al., 2005; Vaismoradi et al., 2014), 14 were quantitative (Al-Otaibi et al., 2018; Armutlu et al., 2008; Basil et al., 2019; Deans, 2005; Fathi et al., 2017; Hicks & Becker, 2006; Kim et al., 2011; Mrayyan et al., 2007; Petrova et al., 2010; Salami et al., 2019; Suclupe et al., 2019; Svitlica et al., 2017; Wolf et al., 2006), 6 were mixed methods (Alomari et al., 2018; Booth et al., 2017; Cohoon, 2011; Jones & Treiber, 2010; Treiber & Jones, 2018; Treiber & Jones, 2012), and one article was an investigation into an error using Root Cause Analysis (RCA) (Dolansky et al., 2013). Six of the identified articles investigated medication errors made by nursing students (Booth et al., 2017; Dolansky et al., 2013; Musharyanti et al., 2019; Reid-Searl et al., 2008; Vaismoradi et al., 2014; Wolf et al., 2006). Thirteen of the articles used a survey to collect data (Al-Otaibi et al., 2018; Armutlu et al., 2008; Cohoon, 2011; Deans, 2005; Fathi et al., 2017; Jones & Treiber, 2010; Kim

et al., 2011; Mrayyan et al., 2007 Petrova et al., 2010; Salami et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; and Treiber & Jones, 2012). Ten of the surveys used were developed by the author, and none of them used the same survey (Al-Otaibi et al., 2018; Armutlu et al., 2008; Cohoon, 2011; Fathi et al., 2017; Jones & Treiber, 2010; Kim et al., 2011; Salami et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; and Treiber & Jones, 2012). Two of the articles used data provided by the MedMarx program, which facilitates the collection and analysis of medication errors (Hicks & Becker, 2006; Wolf et al., 2006). Only 14 articles provided a definition of medication error or near-miss (Alharbi et al., 2019; Alomari et al., 2018; Basil et al., 2019; Cohoon, 2011; Deans, 2005; Fathi et al., 2017; Hicks & Becker, 2006; Mrayyan et al., 2007; Petrova et al., 2010; Salami et al., 2019; Sessions et al., 2019; Svitlica et al., 2017; Vaismoradi et al., 2014; Wolf et al., 2006) with 10 being the definition provided by National Coordinating Council Medication Error Reporting and Prevention (2001) (Alomari et al., 2018; Deans, 2005; Fathi et al., 2017; Hicks & Becker, 2006; Mrayyan et al., 2007; Petrova et al., 2010; Salami et al., 2019; Svitlica et al., 2017; Vaismoradi et al., 2014; Wolf et al., 2006).

There is consistency among the findings despite the differences in data collection methods and categorization of medication administration errors. Distractions and interruptions were identified as a major contributing factor in 14 of the articles (Al-Otaibi, 2018; Alomari, 2018; Armutlu et al., 2008; Cohoon, 2011; Deans, 2005; Härkänen et al., 2018; Jones & Treiber, 2010; Mrayyan et al., 2007; Petrova et al., 2010; Salami et al., 2019; Sessions et al., 2019; Suclupe et al., 2019; Treiber & Jones, 2018; Wolf et al., 2006). Staffing/workload was also identified as a contributing factor in 18 of the articles (Alomari, 2018; Al-Otaibi, 2018; Alharbi, 2019; Cohoon, 2011; Davis et al., 2005; Deans, 2005; Fathi et al., 2017; Härkänen et al., 2018; Jones & Treiber, 2010; Kim et al., 2011; Petrova et al., 2010; Salami et al., 2019; Sessions et al.,

2019; Stetina et al., 2005; Suclupe et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; Treiber & Jones, 2012). Other common findings include inexperience (Alharbi, 2019; Basil et al., 2019; Cohoon, 2011; Davis et al., 2005; Deans, 2005; Jones & Treiber, 2010; Kim et al., 2011; Salami et al., 2019; Treiber & Jones, 2018; Treiber & Jones, 2012; Wolf et al., 2006), lack of following procedure/protocol (Alomari, 2018; Armutlu et al., 2008; Cohoon, 2011; Davis et al., 2005; Hicks & Becker, 2006; Jones & Treiber, 2010; Kim et al., 2011; Musharyanti et al., 2019; Salami et al., 2019; Sessions et al., 2019; Stetina et al., 2005; Svitlica et al., 2017; Treiber & Jones, 2012; Wolf et al., 2006), knowledge deficit (Al-Otaibi, 2018; Armutlu et al., 2008; Deans, 2005; Fathi et al., 2017; Härkänen et al., 2018; Jones & Treiber, 2010; Musharyanti et al., 2019; Petrova et al., 2010; Salami et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; Treiber & Jones, 2012; Vaismoradi et al., 2014; Wolf et al., 2006), lack of communication (Alharbi, 2019; Cohoon, 2011; Deans, 2005; Hicks & Becker, 2006; Kim et al., 2011; Petrova et al., 2010; Svitlica et al., 2017; Wolf et al., 2006), and fatigue (Alharbi, 2019; Al-Otaibi, 2018; Cohoon, 2011; Deans, 2005; Fathi et al., 2017; Mrayyan et al., 2007; Petrova et al., 2010).

Four of the five articles exploring nursing students and medication administration errors categorized contributing factors differently than the other studies making comparisons difficult (Booth et al., 2017; Dolansky et al., 2013; Reid-Searl et al., 2008; Vaismoradi et al. 2014). In a Grounded Theory study by Reid-Searl et al. (2008), the process of nursing students administering medications was explored. The central category identified was “supervision,” revealing a common problem amongst students during administration. The levels of supervision that students encountered ranged from “being with” to “being absent.” While some students did identify distractions or look-alike sound-alike drugs as a contributing factor, the study did not investigate these further.

Musharyanti et al. (2019) conducted a qualitative study in which the students also identified supervision as a contributing factor. It was related to the high workloads of the nursing staff. In addition, students identified a lack of role models as a contributing factor. Students found themselves confused about the medication administration process because they are taught one way and observe nursing staff administering medication, not following the safe medication administration practices they had learned.

Vaismoradi et al. (2014) conducted a study to describe nursing students' perceptions of the causes of medication errors. Two themes were identified: under-developed caring skills in medication management and unfinished learning of safe medication management. The latter theme was further divided into two subthemes: drifting between being worried and being careful, and contextualizing pharmacology education. All the respondents voiced feelings of vulnerability and cited incidents where patient safety was jeopardized.

Booth et al. (2017) conducted a study using mixed methods with both observation and interviews to assess the types of errors generated by nursing students using eMAR technology in high-fidelity simulation. Findings demonstrated that students who are new to the electronic medication administration record had trouble with the processes related to verification of the patient, medication, dosage, and route. They also struggled with the act of scanning using the barcode scanner system and the elements related to the actual administration of the medication. Results indicate that use of the eMAR system should not be conceptualized as a clinical skill that can be taught through low-fidelity skills lab.

Dolansky et al. (2013) used Root Cause Analysis to understand factors contributing to medication errors and avoid blame of an individual. The article presents a case study of a nursing student’s medication error and implements RCA to understand the individual and systemic

factors that led to that error. Several factors were found as a result. Retroactive charting was found to be a significant contributing factor along with a lack of communication and resulted in misunderstandings regarding whether the medication had been administered. Another interesting finding was the influence of the environment and culture on the incident. The student felt intimidated by the nurse to administer medications as soon as possible. Personal factors also contributed to the event, such as role confusion for the student. As a nursing assistant in her job, she felt the administration of the medication would be appreciated by the nurse even though it was ignoring the standard protocol.

Students and New Graduates in the Literature

Of the 15 articles identified in the literature search that included nursing students or new graduates, seven of them did not fit into one of the categories listed previously (Aggar & Dawson, 2014; Emerson et al., 2019; Krautscheid et al., 2011; Lin et al., 2014; Musafiri & Daniels, 2020; Preston et al., 2019; Reid-Searl et al., 2010). Four of the articles were investigations into student nurse perceptions of their education and safe medication administration (Aggar & Dawson, 2014; Krautscheid et al., 2011; Musafiri & Daniels, 2020; Preston et al., 2019). Lin (2014) investigated the learning experiences of students in pediatric medication management. Reid-Searl et al. (2010) investigated the importance of direct supervision for avoiding medication administration errors. Emerson et al. (2019) used the experiences of clinical faculty and nursing students medication errors and near-misses to develop a reporting form.

Discussion

Of the 71 articles identified in the literature review, none of them are from the perspective of the nursing clinical instructor on the factors contributing to student nurse

medication administration errors and near-misses. Only five of the identified articles investigated medication errors made by nursing students (Booth et al., 2017; Dolansky et al., 2013; Musharyanti et al., 2019; Reid-Searl et al., 2008; Vaismoradi et al., 2014; Wolf et al., 2006). The studies all differed in the way perceptions were measured. While some of the articles utilized researcher-developed tools (Treiber & Jones, 2018), others utilized individual interviews or focus groups (Booth et al., 2017; Musharyanti et al., 2019; Reid-Searl et al., 2008; Vaismoradi et al., 2014). Dolansky et al. (2013) presented a case study, and the application of RCA and Wolf (2006) utilized data available in MEDMARX, a national, voluntary, internet-accessible database. Inconsistencies in the measurement of perceptions make comparison of results difficult. Only one of the studies had an identifiable theory to provide structure and support for the study's rationale, the problem statements, the purpose, significance, and the research questions (Reid-Searl, 2008).

Conclusion

There is a paucity of literature specific to medication safety in nursing education, particularly contributing factors to medication errors or near-misses. Much of the literature examining medication errors in nursing education focuses on teaching strategies for drug calculations. However, the literature does not identify this as a significant contributing factor (Harding & Petrick, 2008).

The articles identified in this literature review do not use a standardized definition or shared conceptual framework. Standardizing the definitions and utilization of a shared conceptual framework may help researchers develop strong measurements that accurately characterize the barriers to safe medication administration.

None of the identified articles explore near-misses. A study by Balas et al. (2006) found that critical care nurses reported more near-misses than actual errors. This information is important as it could identify significant aspects of the system functions that require change. Student nurses are most often supervised by clinical instructors; therefore, including the identification of the contributing factors of near-misses, and actual medication errors may reveal further aspects of the system functions, and educational deficits that can be addressed.

The Robert Wood Johnson Foundation funded the development of Quality and Safety Education for Nurses Institute (QSEN Institute) to create competencies in quality improvement in prelicensure nursing students (Cronenwett et al. 2007). These competencies were developed to prepare future nurses in a culture of safety, so they carry that forward into their careers. Nurse educators have a responsibility to identify safety concerns and address them accordingly. Addressing the gap in the literature can lead to a better understanding of the factors that contribute to the problem and lead to improvements in teaching medication safety.

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CHAPTER 3

METHODS

INTRODUCTION

This chapter presents the details of the methodological issues and techniques applied to answer the research questions. The study aims to investigate pre-licensure undergraduate nursing clinical instructor perspectives of the factors that contribute to nursing student's medication administration errors and near-misses.

Purpose

The purpose of this study is to:

- Identify the factors contributing to student nurse medication administration errors and near-misses in the clinical setting as identified by undergraduate prelicensure clinical instructors.
- Investigate how undergraduate prelicensure nursing clinical instructors describe the factors that contribute to student medication errors and near-misses.
- Evaluate whether the level of student taught impacts the factors identified.
- Evaluate whether the level of student taught impacts the number of errors and near-misses identified by clinical instructors.
- Investigate the teaching strategies and equipment most used to teach safe medication administration and those identified by instructors to improve nursing student medication management.

Research Questions

The research questions are:

Question 1

What are the factors that undergraduate nursing prelicensure clinical instructors perceive as contributing factors to students administering medications safely?

Question 2

How do clinical instructors describe the factors identified as contributing to medication error?

Question 3

Do the factors identified by the undergraduate nursing clinical instructors differ by level of student taught?

Hypothesis. There is a statistically significant difference in clinical instructor perceptions of contributing factors to undergraduate nursing students' medication errors and near-misses based on level of student taught.

Question 4

Do undergraduate nursing clinical instructors report differences in frequency of medication errors and near-misses based upon level of student taught?

Hypothesis. There is a statistically significant difference in the number of medication errors and near-misses reported by undergraduate nursing clinical instructors based upon level of student taught.

Question 5

What teaching strategies are most used to teach safe medication administration?

Question 6

What activities and equipment are most frequently used to teach safe medication administration?

Question 7

What activities do undergraduate clinical instructors identify that would improve nursing student medication management?

Research Design

A non-experimental, cross-sectional descriptive survey design was used to investigate clinical instructors' perceptions of the factors contributing to undergraduate nursing students' medication errors and near-misses in not administering medications safely and the interventions that may help mitigate these factors. There is a paucity of literature that identifies the contributing factors to undergraduate nursing students' medication errors and near-misses. Descriptive research is used to document certain factors of a situation (Polit & Beck, 2012). The data can then be used for hypothesis generation or theory development (Polit & Beck, 2012). When using descriptive designs, there are several implicit assumptions. One assumption is that the variable exists within the population and can be described. Based on the literature review and the identified gap, the dependent variable reflects the clinical nursing instructor's perceptions of factors that contribute to medication administration errors and near-misses in undergraduate nursing students. The moderating variables are level of student taught, years of experience as a clinical instructor, and program degree type.

Instrument Development

Demographic information such as nursing program type, clinical instructor years of experience as a nurse and clinical instructor, and student preparation methods was collected (see Appendix A). Two additional open-ended questions are included to answer the fifth research question to assess any additional interventions the clinical instructors use to enhance medication

administration teaching and any additional activities the instructors feel may improve medication safety.

The instrument utilized was the Medication Administration Error Reporting Survey (MAE Survey) developed by Wakefield et al. (2005) (see Appendix B). The author of the survey granted permission to use and modify the tool (see Appendix C). Prior studies demonstrated validity and reliability. Its use has been demonstrated with nursing students from associate degree programs and bachelor's degree programs (Teal, 2019). The original MAE Survey is a 77-item survey comprised of four sections, using a 6-point Likert scale. The first section contains 29 questions regarding nurses' perceptions of the contributing factors of medication errors. The second section contains 15 questions covering the nurse's perceptions of why medication administration errors are not reported. The third section contains 20 questions that cover nurses estimated percentage of medication errors that are reported. The fourth section contains 14 questions collecting demographic data from the respondents. This study will use selected questions from the first section on the reasons why errors occur.

Initially, the MAE Survey was developed and pilot-tested as part of a hospital quality improvement project (Wakefield et al., 2005). Between 1994 and 2001, it was administered four times to Iowa acute care hospital nurses statewide. Initially, items were developed to reflect the most common reasons why errors occur based on the literature. A panel of nurse experts reviewed individual items, and following revisions, it was pilot tested on several nursing units. Following further revisions, the survey was then distributed to the study hospitals in 1994. In 1996, based on an updated literature review, ten items were added to the first section, "Reasons Why Errors Occur." Principle components exploratory-factor analysis with orthogonal rotation was used to determine if subscales could be identified. Using an Eigenvalue criterion of 1.0 or

greater, subscale factors were established. Individual items with a factor loading of 4.0 or greater were included in the factor. In the first section, "why errors occur," five factors were identified. These factors are physician communication, medication packaging, transcription related, pharmacy processes, and nurse staffing. Once these subscales were finalized, individual items were reviewed and assessed for face validity, and confirmatory factor analysis established construct validity. Subscale reliability of the first section, "why errors occur," was assessed using Cronbach's Coefficient Alpha (Wakefield et al., 2005). Internal consistency within each subscale was within an acceptable range (0.73 – 0.90). Test-retest was assessed, and Pearson's *r* was used to assess reliability with correlations at 0.53 to 0.78 for the first section, "why errors occur" (Wakefield et al., 2005).

In a more recent study conducted by Hogan (2006), factor analysis using varimax rotation with an Eigenvalue criterion of 1.0 or greater and a factor loading criterion of 0.50 or greater revealed five factors in the first section of the MAE Survey; physician, systems, pharmacy, industry, and knowledge. The five factors explained 63.424% of the total variance for the 19 items that loaded onto the factors. The Cronbach's alpha coefficient was calculated to be 0.813 for the 19 items.

For the purposes of this study, the modified MAE Survey from the study conducted by Hogan (2006) was used. Two questions were removed that pertained to the legibility of written orders or abbreviations in written orders because electronic order entry has eliminated handwritten orders. One question pertaining to verbal orders was eliminated as students would not be taking verbal orders from a provider. One question pertaining to nurses being pulled in different directions and onto different teams was eliminated as students are generally caring for one or two patients at a time. One question regarding unit staffing levels was eliminated since

staffing levels would not affect the workload of a student. Only the first section of the survey, "why errors occur," is being used for this study.

Fourteen questions remained after removal of these items (see Appendix D). The term near-miss was also added to the tool since students are not passing medications independently, and therefore most errors should be caught before reaching the patient. The first factor "physician" is assessed in question 18. The second factor "systems" is assessed in questions 25, 26, 27, and 28. The third factor, "pharmacy" is assessed in questions 19, 20, and 21. The fourth factor, "industry" is assessed in questions 15, 16, and 17. The fifth factor, "knowledge", is assessed in questions 22, 23, and 24.

The first research question concerning the identification of the factors contributing to student errors and near-misses was answered using descriptive statistics to analyze the individual contributing factors on the survey. The second research question, "How do clinical instructors describe the factors identified as contributing to medication errors?" was answered by a content analysis of the open-ended questions. Question three, "Do the factors identified by the undergraduate nursing clinical instructors differ by level of student taught?" was answered using Kruskal-Wallis to examine the differences on the factors of systems, pharmacy, industry, knowledge, and physician according to the level of student taught (early, middle, late). Question four, "Do undergraduate nursing clinical instructors report differences in frequency of medication errors and near-misses based upon level of student taught?" was answered using Kruskal-Wallis to examine differences on the number of errors and near-misses reported according to the level of student taught. Question five, "What teaching strategies are most commonly used to teach safe medication administration?" and question six, "What activities and equipment are most frequently used to teach safe medication administration?" were answered

using descriptive statistics, means, and standard deviations. Question seven, "What activities do undergraduate clinical instructors identify that would improve nursing student medication management?" was answered by the open-ended question at the end of the survey "Are there any educational activities you think would enhance the safety of undergraduate nursing student medication safety?

Construct validity can be hypothesized through the analysis of Reason's model of accident causation. All of the questions in the first section of the survey reflect the mechanisms that govern performance, the nature of the task of medication administration and the environment in which it occurs, and the nature of the individuals involved in the process. Personal aspects are reflected in questions 18 and 24. Human engineering aspects are reflected in survey items 15, 16, 17, and 27. Organizational safety is reflected in questions 19, 20, 21, 22, 23, 25, 26, and 28.

Contributing factor variables

Contributing factors were measured using the modified MAE survey, including 14 items (see Appendix D). The modified MAE survey was quantified using a 6-point response format (1= strongly disagree 2=moderately disagree, 3=slightly disagree, 4=slightly agree, 5=moderately agree, 6=strongly agree). To identify agreement of respondents, the values 1, 2, and 3 were recoded as "Disagreed" while the values 4, 5, and 6 were recoded as "Agreed."

The 14 items are distributed across the five latent factors based on Hogan's study as follows: physician (question 18), systems (questions 25, 26, 27, and 28), pharmacy (questions 19, 20, and 21), industry (questions 15, 16, and 17), and knowledge (questions 22, 23, and 24).The responses of each latent factor were summed and divided by the number of questions to obtain the latent factor score.

The 14 questions were also categorized based on Reason's model, which includes three domains as follows: personal aspect (questions 18 and 24), human engineering (questions 15, 16, 17, and 27), and organizational safety (questions 19, 20, 21, 22, 23, 25, 26, and 28). The modified MAE survey was quantified using a 6-point response format (1= strongly disagree 2=moderately disagree, 3=slightly disagree, 4=slightly agree, 5=moderately agree, 6=strongly agree), with responses being summed and divided by the number of questions to obtain the latent factor score.

Setting and Sample

Sample

The participants for this study were nursing clinical instructors from undergraduate prelicensure nursing programs throughout the State of Illinois. Non-probability purposive sampling was utilized to achieve a representative sample of undergraduate nursing clinical instructors. This sampling method permits the researcher to select the participants who possess knowledge of the phenomenon of interest (Polit & Beck, 2012). Inclusion criteria were undergraduate clinical nursing instructors in the State of Illinois. Exclusion criteria included clinical instructors of master's entry-level nursing programs, accelerated Bachelor of Science programs, and online nursing programs. Within the State of Illinois, there are 44 associate degree programs, 36 bachelors programs, and one hospital-based program.

A power analysis was conducted to determine the sample size for the population. The power analysis was conducted to reduce the risk of Type II error (Polit & Beck, 2012). The power analysis consists of three steps. Step one is to consider the alpha. The alpha is the level of statistical significance of a study (Polit & Beck, 2012). A significance level of .05 means that the researcher could be wrong 5 out of 100 times. A significance level of .05 allows for a narrow

margin of variation. There is a possibility of variation because the clinical instructors misinterpreted survey questions, or human error when completing the survey. The second step of a power analysis is to select the desired power. Power reflects the probability of rejecting a false null hypothesis (Polit & Beck, 2012). The power selected for this study is .80.

The third step in the power analysis is to select the effect size. The effect size is an estimate of how inaccurate the null hypothesis is, or how strong the relationship is between the independent variable and the dependent variable (Polit & Beck, 2012). An estimated effect size of .30 was chosen for this study based on Cohen's d, which is a small to medium effect size for group comparisons (Cohen, 1988). Utilizing G*Power analysis, the approximate sample size necessary is 111 for a power of .80, an effect size of .30 with three groups, and alpha at .05.

Recruitment

An invitation email was sent via email to the Deans, Chairs, and Directors of undergraduate nursing programs in the State of Illinois in April of 2020 (see Appendix E). The recruitment email was attached to the invitation email for distribution to participants (see Appendix F). When prospective participants clicked on the URL link to the survey, participants were prompted to read the instructions for giving informed consent. The informed consent contained information explaining the voluntary and anonymous nature of the survey/study, its purpose and potential benefits, duration of participation, procedure for safeguarding data and reporting of results, and any reasonable, foreseeable risks (see Appendix G). The researcher's name and contact information and whom participants may contact about their rights were included in the recruitment email. To indicate their willingness to participate in the study, the respondents clicked on the link to the survey. Data was collected from April to June 2020.

Ethical considerations

The study posed minimal risk to participants. The most likely risk is a breach of confidentiality. Approval was obtained from the University of Wisconsin Milwaukee (UWM) Institutional Review Board to conduct the study with exempt status (see Appendix H).

Data Collection Procedures

Data Collection

Data was collected using the Qualtrics survey system using the developed tool. No personal information was collected from participants. No intervention was used. Participants were asked to read the various elements of informed consent before participating. Participants gave consent for participation by clicking on the link to the actual survey questionnaire. Data was collected through the secure and password protected online Qualtrics survey system. Data from the Qualtrics survey system was exported into SPSS software for analysis and data storage. Study data was only accessible by the researcher through password protection. The SPSS data was copied and stored on a secure, password-protected USB flash drive. The USB flash drive was kept in a locked cabinet in the researcher's home office when not in use.

Data Analysis Plan

Analysis of data was performed using SPSS using descriptive statistics. The mean, frequencies, and standard deviations were used to analyze the individual and latent factors of the survey of contributing factors, the teaching strategies, and the activities and equipment used to teach safe medication administration. Kruskal-Wallis test was used to examine differences between the categorical variables of level of student and the interval level mean scores of contributing factors to medication errors categorized by Hogan: physician, systems, pharmacy, industry, and knowledge. Kruskal-Wallis test was also used to examine the differences between

the categorical variables of level of student and the interval level mean scores of the factors categorized based on Reason's model: personal, human engineering, and organizational safety. Because the factors are measured using ordinal scales and not considered continuous variables they do not fulfill the criteria required for parametric testing. Therefore, non-parametric tests, such as Kruskal-Wallis was used to compare the variables between three or more groups. A content analysis was done on the two open-ended questions to explore themes identified within the narratives. Themes expected to be identified are those of weaknesses in the education of medication administration as identified by the clinical instructors and potential enhancements to the current curriculum. A summary of variables and statistical analysis used for each research question can be found in Table 3.1.

Table 3.1

Summary of Variables

Research Question	Variables/Measures	Statistics
Question 1: What are the factors that undergraduate nursing prelicensure clinical instructors perceive as contributing factors to students administering medications safely?	Individual contributing factors by MAE Survey	Descriptive statistics: Frequencies & Percentages
Question 2: How do clinical instructors describe the factors identified as contributing to medication error?	Open-ended questions	Content analysis

Research Question	Variables/Measures	Statistics
Question 3 Do the factors identified by the undergraduate nursing clinical instructors differ by level of student taught?	IV: Level of student taught (nominal) by demographic survey DV: Individual and Latent factors in MAE Survey (Categorical/Ordinal)	Mean comparisons using Kruskal-Wallis
Question 4 Do undergraduate nursing clinical instructors report differences in frequency of medication errors and near-misses based upon level of student taught?	IV: Level of student taught (nominal) DV: Number of errors and near-misses (Continuous/Ordinal)	Mean comparisons using Kruskal-Wallis
Question 5 What teaching strategies are most used to teach safe medication administration?	Survey question 8	Descriptive statistics: Means, frequencies
Question 6 What activities and equipment are most frequently used to teach safe medication administration?	Survey question 9	Descriptive statistics: Means, frequencies
Question 7 What activities do undergraduate clinical instructors identify that would improve nursing student medication management?	Open-ended Questions	Content analysis

Limitations

Several limitations exist in the design of the study. A threat to external validity is the potential for a non-response bias (Polit & Beck, 2012). Potential threats to validity include the fact that the sample was selected from one midwestern state and limits generalizability of the findings to other areas of the country. However, this study fills a gap in the research and can be

replicated, expanding it to the rest of the country. Another limitation is selection bias since the Deans and Directors are given a choice to offer the survey to their clinical instructors. Clinical instructor participation depends upon gatekeeper permission in the form of the Deans and Directors forwarding the email to the clinical instructors. Self-reported data from any survey is potentially subject to social desirability bias, which is also a threat to internal validity (Polit & Beck, 2012). However, ensuring confidentiality may have helped to minimize this. Finally, the use of Qualtrics to complete the survey is also a threat to internal validity as the population may only reflect those who were comfortable with online surveys.

Conclusions

This study used a non-experimental cross-sectional design and two open-ended questions to identify the contributing factors to student nurse medication administration errors and near-misses in the clinical setting as identified by clinical instructors.

CHAPTER 4

RESULTS

INTRODUCTION

The program of research is aimed at examining the contributing factors to medication administration errors and near-misses by undergraduate prelicensure nursing students as perceived by clinical instructors. This chapter presents the manuscript that details the research study done to address this question.

Manuscript Two: The Perceptions of Undergraduate Prelicensure Clinical Instructors on the Contributing Factors to Medication Error and Near-Misses of Nursing Students

Kristen M. Selig, MS, RN

University of Wisconsin - Milwaukee

Abstract

Background: Factors contributing to student nurse medication administration errors have been identified in the literature, including human factors and system factors.

Methods: A non-experimental, cross-sectional descriptive design was used to investigate clinical instructors' perceptions of the factors contributing to undergraduate prelicensure nursing students' medication errors and near-misses. A modified version of the Medication Administration Error Reporting Survey (MAE Survey) was utilized.

Results: Responses totaled 119, with 75 from associate degree programs and 44 from bachelor's degree programs. A Kruskal-Wallis test was conducted to examine the differences on the factors of systems, pharmacy, industry, knowledge, and physician according to the level of student taught (early, middle, late). No significant differences were found. The top three factors identified within the MAE Survey were Industry, Systems, and Knowledge.

Conclusion: Participants indicated that students need more repetition outside of the clinical setting and in the nursing laboratory. A 'back to basics' approach was suggested, incorporating all of the technology and equipment into their education.

Introduction

In 2000 the Institute of Medicine (IOM) report, *To Err is Human,* raised awareness of medication safety in the United States healthcare system. At least 25% of all medication errors are preventable (IOM, 2007). The most frequent occurrences are during the prescribing and

administration stages (IOM, 2007). Nurses are responsible for the administration stage, which includes administering medications and monitoring for effectiveness and side effects. There is no other professional to intervene at the point of administration, and reports have suggested that nurses are responsible for up to 38% of medication errors (Bates, 2007). Further, 49% to 53% of novice nurses are involved in errors of nursing care (Smith & Crawford, 2003; Kenward & Zhong, 2006).

While the majority of research regarding medication errors at the point of administration focuses on registered nurses, student nurses have been identified as well (Harding & Petrick, 2008; Hess et al., 2016; Reid-Searl & Happell, 2011; Wolf et al., 2006). Nursing students must function as learners in the clinical setting and be under the direct supervision of their clinical instructors or preceptors during the medication administration process. According to Perry & Koharchik (2014), administration errors should not be occurring in this context.

Background

Factors contributing to student nurse medication administration errors have been identified in the literature and include human factors such as knowledge deficits and inexperience (Deans, 2005; Fry & Dacey, 2007; Harding & Petrick, 2008; Sears et al., 2013; Treiber & Jones, 2012; Wolf et al., 2006) as well as factors within the organization such as busyness and distractions (Deans, 2005; Fry & Dacey, 2007; Harding & Petrick, 2008; Johnson et al., 2017; Jones & Treiber, 2010; Sears et al., 2013; Smeulers et al., 2014; Treiber & Jones, 2012; Wolf et al., 2006). There is a paucity of literature from the clinical instructor's perspective on the contributing factors to nursing student medication administration errors and near-misses.

Literature Review

A total of 28 articles published between 2005 and 2020 in English were identified under the theme factors contributing to medication administration errors. Despite the differences in data collection methods and categorization of medication administration errors, there is consistency among the findings, centering around four themes:

1. barriers to reporting errors,
2. solutions or strategies for reducing the number of errors,
3. medication calculations, and
4. contributing factors to medication administration errors.

Only four articles were identified that investigated student nurse perceptions of safe medication administration (Aggar & Dawson, 2014; Krautscheid et al., 2011; Musafiri & Daniels, 2020; Preston et al., 2019). The only article identified that investigated clinical instructors' perceptions was an article by Emerson et al. (2019) that used the experiences of clinical instructors as well as nursing student's medication errors and near-misses to develop a reporting form.

Barriers to Error Reporting

Eleven articles addressed the theme "barriers to error reporting." Of the identified articles, six of them used the MAE Survey developed by Wakefield (Bifftu et al., 2016; Chiang & Pepper, 2006; Covell & Ritchie, 2009; Kim, 2012; Petrova et al., 2010; You et al., 2015). Personal, organizational, and cultural barriers were identified in all of the studies. Fear was identified as a significant barrier in multiple studies (Al-Otaibi et al., 2018; Bifftu et al., 2016; Chiang & Pepper, 2006; Covell & Ritchie, 2009; Kim et al., 2011; Kim, 2012; Petrova et al., 2010; You et al., 2015). Workload, lack of time, and reporting effort were also a barrier (Fathi et

al., 2017; Kim, 2012; Waaseth et al., 2019). It was also identified that if the nurse did not feel the error was serious (Lee et al., 2018) or did not agree that time was an error (Bifftu et al., 2016), it was not reported. None of the identified articles focused on reporting medication errors by nursing students or newly graduated students.

Solutions or Strategies for Reducing the Number of Errors

A total of 22 articles addressed the theme solutions or strategies for reducing the number of errors. Six of the articles focus on interruptions and distractions (Palese et al., 2019; Pape et al., 2005; Pape et al., 2013; Verweij et al., 2014; Westbrook et al., 2017; Williams et al., 2014). Four of the articles focus on smart intravenous pump systems as they relate to decreasing medication errors (Bowcutt et al., 2008; Mason et al., 2014; Rosenkoetter et al., 2008; Rothschild et al., 2005). Five articles focused on an education program, such as medication safety (Dennison, 2007; Schneider et al., 2006; Tan et al., 2017), simulation to impact patient safety(Sears et al., 2010), or faculty development to impact student medication administration safety (Perry & Koharchik, 2014). Three articles focus on electronic medication dispensing systems and their relationship to patient safety (Rochais et al., 2014; Smith et al., 2016; Van De Vreede et al., 2017). One article focused on the decentralization of medication distribution to the bedside (Bennett et al., 2006) and two articles focused on the effect of bar code scanning on medication errors (Gooder, 2011; Ulanimo et al., 2007). One article discussed the impact of systems thinking on medication errors (Tetuan et al., 2017). The only articles that focused specifically on students and new graduates were the articles by Perry & Koharchik (2014) and Sears et al. (2010).

Medication Calculation

A total of 10 articles addressed the theme medication calculations. Six of the articles concerned students and new graduates (Harne-Britner et al., 2006; Hurley, 2017; Mackie & Bruce, 2016; Őzünal et al., 2020; Ramjan et al., 2014; Simonsen et al., 2014). Two of the articles were investigations into drug calculation skills of nurses (Fleming et al., 2014) and nursing students (Őzünal et al., 2020). Fleming et al. (2014) found that the most frequent errors were conceptual errors, and there were inconsistencies in the amount of pharmacology throughout the curriculum and the skills taught.

Contributing Factors

Distractions and interruptions were identified as a major contributing factor in 14 of the articles (Al-Otaibi et al., 2018; Alomari et al., 2018; Armutlu et al., 2008; Cohoon, 2011; Deans, 2005; Härkänen et al., 2018; Jones & Treiber, 2010; Mrayyan et al., 2007; Petrova et al., 2010; Salami et al., 2019; Sessions et al., 2019; Suclupe et al., 2019; Treiber & Jones, 2018; Wolf et al., 2006). Staffing/workload was also identified as a contributing factor in 18 of the articles (Alomari et al., 2018; Al-Otaibi et al., 2018; Alharbi, 2019; Cohoon, 2011; Davis et al., 2005; Deans, 2005; Fathi et al., 2017; Härkänen et al., 2018; Jones & Treiber, 2010; Kim et al., 2011; Petrova et al., 2010; Salami et al., 2019; Sessions et al., 2019; Stetina et al., 2005; Suclupe et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; Treiber & Jones, 2012). Other common findings include inexperience (Alharbi, 2019; Basil et al., 2019; Cohoon, 2011; Davis et al., 2005; Deans, 2005; Jones & Treiber, 2010; Kim et al., 2011; Salami et al., 2019; Treiber & Jones, 2018; Treiber & Jones, 2012; Wolf et al., 2006), lack of following procedure/protocol (Alomari et al., 2018; Armutlu et al., 2008; Cohoon, 2011; Davis et al., 2005; Hicks & Becker, 2006; Jones & Treiber, 2010; Kim et al., 2011; Musharyanti et al., 2019; Salami et al., 2019;

Sessions et al., 2019; Stetina et al., 2005; Svitlica et al., 2017; Treiber & Jones, 2012; Wolf et al., 2006), knowledge deficit (Al-Otaibi et al., 2018; Armutlu et al., 2008; Deans, 2005; Fathi et al., 2017; Härkänen et al., 2018; Jones & Treiber, 2010; Musharyanti et al., 2019; Petrova et al., 2010; Salami et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; Treiber & Jones, 2012; Vaismoradi et al., 2014; Wolf et al., 2006), and lack of communication (Alharbi, 2019; Cohoon, 2011; Deans, 2005; Hicks & Becker, 2006; Kim et al., 2011; Petrova et al., 2010; Svitlica et al., 2017; Wolf et al., 2006), and fatigue (Alharbi, 2019; Al-Otaibi et al., 2018; Cohoon, 2011; Deans, 2005; Fathi et al., 2017; Mrayyan et al., 2007; Petrova et al., 2010). Only seven of the identified articles investigated medication administration errors made by nursing students (Booth et al., 2017; Dolansky et al., 2013; Musharyanti et al., 2019; Reid-Searl et al., 2008; Treiber & Jones, 2018; Vaismoradi et al., 2014; Wolf et al., 2006).

The identified studies all differed in the way perceptions were measured. While some of the articles utilized researcher-developed tools (Treiber & Jones, 2018), others utilized individual interviews or focus groups (Booth et al., 2017; Musharyanti et al., 2019; Reid-Searl et al., 2008; Vaismoradi et al., 2014). Dolansky et al. (2013) presented a case study and the application of Root Cause Analysis (RCA), and Wolf (2006) utilized data available in MEDMARX, which is a national, voluntary, internet-accessible database. Inconsistencies in the measurement of perceptions make comparison of results difficult. Only one of the studies had an identifiable theory to provide structure and support for the study's rationale, the problem statements, the purpose, significance, and the research questions (Reid-Searl, 2008).

None of the identified articles explored near-misses. A study by Balas et al. (2006) found that critical care nurses reported more near-misses than actual errors. This information is essential as near-misses could help identify major aspects of the system functions that require

change. Student nurses are most often supervised by clinical instructors; therefore, including the perceptions of the clinical instructors in identifying contributing factors to medication administration errors and near-misses may reveal further aspects of the system functions, and educational deficits that can be addressed. There is a gap in the literature specific to medication safety in nursing education, particularly the contributing factors to medication errors or near-misses.

Aim of the Study

The study aimed to investigate undergraduate prelicensure nursing clinical instructor's perceptions of the factors that contribute to students administering medications safely and how they describe them as contributing to medication errors. The study also aimed to investigate whether the factors identified differ by level of student taught and whether they report differences in the frequency of medication errors or near-misses based upon level of student taught. Instructors were also asked to report the teaching strategies, activities, and equipment used to teach safe medication administration and if any activities would improve nursing student medication management.

Theoretical Framework

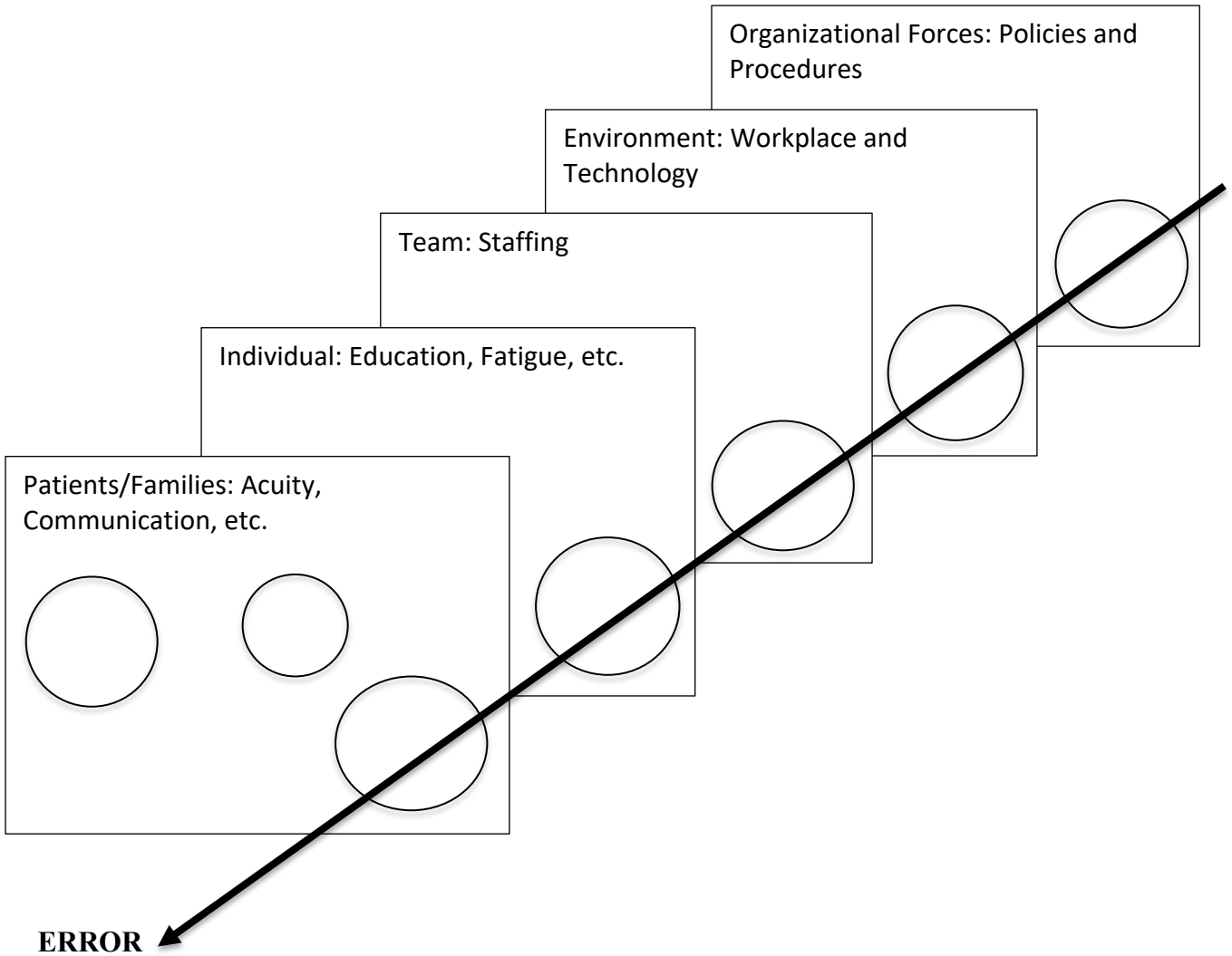
Reason's Swiss Cheese Model of Accident Causation illustrates the conceptualization of accident causation and the interplay of the forces within healthcare involved in the accident trajectory (see Figure 4.1). Reason's Model of Accident Causation has been used extensively in healthcare research to explore the concept of error. Therefore, it will provide the structural framework to examine the factors that contribute to medication errors and near-misses in undergraduate nursing students.

Each slice in the swiss cheese model represents one of the multiple factors within a healthcare organization that provides a barrier to protect patients from errors. However, each layer contains holes that represent the active failures or latent conditions in the organizational defenses. These layers are dynamic and in continuous flux within the healthcare environment, and, when line up, can result in an accident opportunity.

There is a complex interplay among three forces within an organization that gives rise to errors (Reason, 1990). These forces are the nature of the task and environment, mechanisms governing performance, and the nature of the individual. In error detection and prevention, understanding these three forces is crucial. The nature of the work and the environment within which it occurs must be identified to establish the conditions under which the error occurred. The mechanisms governing performance, such as the policies and procedures in place, help identify organizational forces that may give rise to errors. Finally, the nature of the individual comprises the cognitive level of the working system.

Figure 4.1

Reason's Swiss Cheese Model of Accident Causation



Method

Design and Sample

A non-experimental, cross-sectional descriptive design was used to investigate clinical instructors' perceptions of the factors contributing to undergraduate prelicensure nursing students' medication errors and near-misses. Permission was obtained from the Institutional Review Board of the University of Wisconsin, Milwaukee. Invitational emails were sent to the

Deans, Directors, and Chairs of all associate degree and bachelor's degree undergraduate nursing programs in a midwestern state. Recruitment emails were attached to the invitation email for distribution to participants.

Definition of Medication Errors and Near-Misses

The National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) defines medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures, and systems, including prescribing, order communication, product labeling, packaging, and nomenclature, compounding, dispensing, distribution, administration, education, monitoring, and use" (NCCMERP, 2020) This definition is broad and encompasses disciplines outside of nursing, and has the previous definitions embedded within, and will therefore be utilized in this literature review.

Near-misses can provide a wealth of information that can inform error prevention strategies. However, it is assumed that like medication errors, near-misses are also grossly under-reported (Williamson, 2009). For the purposes of this literature review, the definition used is the one provided by ISMP, which is an event, situation, or error that took place but was captured before reaching the patient.

Instrument

The instrument that was utilized was the MAE Survey developed by Wakefield et al. (2005). Permission to use and modify the tool was granted by the author. Prior studies demonstrated validity and reliability. Its use has been demonstrated with nursing students from both associate degree programs and bachelor's degree programs (Teal, 2019). The original MAE

Survey is a 77-item survey comprised of four sections, using a 6-point Likert scale. The first section contains 29 questions regarding nurses' perceptions of the contributing factors of medication administration errors. The second section contains 15 questions covering the nurse's perceptions of the reasons medication administration errors are not reported. The third section contains 20 questions that cover nurses estimated percentage of medication errors that are reported. The fourth section contains 14 questions collecting demographic data from the respondents. This study used selected questions from the first section of the survey on the reasons why errors occur.

The modified MAE Survey from the study conducted by Hogan in 2006 was used. Demographic information such as nursing program type, clinical instructor years of experience as a nurse and clinical instructor, methods of student preparation and assessment, etc., was also collected. Two additional open-ended questions were included to assess any additional interventions the clinical instructors use to enhance medication administration teaching and any additional activities the instructors feel may improve medication safety

Ethical Considerations

The study posed minimal risk to participants. Approval was obtained from the University of Wisconsin Milwaukee's Institutional Review Board.

Data Analysis

Analysis of data was performed using SPSS. The mean, frequencies, and standard deviations were used to analyze the individual question responses. Kruskal-Wallis test was used to examine differences between the categorical variable of level of student and the interval level mean scores of contributing factors to medication errors; physician, systems, pharmacy, industry,

and knowledge. A content analysis was done on the two open-ended questions to explore themes identified within the narratives.

Results

Respondents

A total of 142 survey responses were received. Thirty-six of the respondents answered the survey twice, as requested, for each level of student taught (early, middle, or late program). A total of 23 responses were removed due to missing data leaving a total of 119 useable surveys. Of the 119 responses, 75 were from associate degree programs, while 44 were from bachelor's degree programs. Forty-two of the respondents teach in the early part of the program, which is defined as the first 1/3 of the program. Thirty-three participants teach in the middle third of the program, and 44 teach in the last third of the program. The participant's experience in practice ranged from three to 47 years, and teaching experience ranged from one to 36 years (see Table 4.1). Reliability of the MAE Survey was assessed using Cronbach's Alpha (.840), indicating a high level of internal consistency.

Table 4.1

Participant Demographics

	N	Range	Minimum	Maximum	Mean	SD
Years Experience Practicing	119	44	3	47	25.44	11.58
Years Experience Teaching	119	35	1	36	10.05	8.41

Test Research Questions

Research question one: What are the factors that undergraduate nursing clinical instructors perceive as factors contributing to students administering medications safely? The top 5 most common individual contributing factors of medication errors and near-misses that were

agreed on were ‘students have limited knowledge about medications,’ ‘the names of many medications are similar,’ ‘all medications for one team of patients cannot be passed within an accepted time frame,’ ‘the packaging of many medications is similar,’ and ‘students do not receive enough instruction on medications’ (see Table 4.2).

Table 4.2

Individual contributing Factors to Medication Errors and Near-Misses

Latent Factor	Contributing Factor	*n* (%)
Industry	The names of many medications are similar	98 (82.3)
	The packaging of many medications is similar	78 (65.5)
	Different medications look alike	70 (58.8)
Knowledge	Students have limited knowledge about medications	100 (84.1)
	Students do not receive enough instruction on medications	75 (63)
	There is no easy way to look up information on medications	27 (22.7)
Systems	All medications for one team of patients cannot be passed within an accepted time frame	86 (72.2)
	Students are interrupted while administering medications to Perform other duties	73 (62.1)
Physician	Physicians' medication orders are not clear	57 (47.9)
Pharmacy	All medications for one team of patients cannot be passed within an accepted time frame	86 (72.2)
	Patients are off the unit for other care	51 (42.9)
	Equipment malfunctions or is not set correctly (e.g., IV pump)	47 (39.5)
	Pharmacy delivers incorrect doses to this unit	42 (35.3)
	Pharmacy does not prepare the med correctly	30 (25.2)
	Pharmacy does not label the med correctly	27 (22.6)

Question two: How do clinical instructors describe the factors identified as contributing to medication errors? A content analysis was done on the open-ended questions. Themes

identified included ‘not enough practice,’ ‘not understanding medication rights,’ ‘familiarity with equipment,’ ‘math,’ and ‘distractions.’ Twenty-six percent of the responses indicated that students are not getting enough practice or repetition with the skill of medication administration. A total of 31 out of 106 instructors verbalized the need for more hands-on practice. Ten of the instructors verbalized that students do not understand the medication “rights.” Six responses indicated a lack of familiarity with equipment such as insulin pens, pyxis, eMAR, and scanning. Six responses indicated difficulty with math calculations. Three responses indicated that the nurses are rushed and even handing students medications to administer that may be incorrect. Two indicated that distractions are an issue.

Question three: Do factors identified by the undergraduate nursing clinical instructors differ by level of student taught? The hypothesis of this research question was there is a statistically significant difference in clinical instructor perceptions of contributing factors to undergraduate nursing students’ medication errors and near-misses based on level of student taught. To test this hypothesis, the latent factors were instead of individual factors. First, the means and standard deviations were identified of the latent factors based on Hogan’s study and Reasons model, respectively (see Table 4.3). The non-parametric test Kruskal-Wallis tests were conducted to examine the differences on the factors according to the level of student taught (early, middle, late), and no significant differences were found (see Tables 4.4 and 4.5).

Table 4.3

Means, SDs, and Ranges of Each Latent Factor by Level of Student Taught

Latent Factor		N	Mean	SD	Range Minimum	Range Maximum
Latent Factors from Hogan's study						
Systems	Early Program	42	3.4405	1.09434	1	6
	Middle Program	33	3.6045	.85954	1	6
	Late Program	44	3.4261	1.03230	1	6
	Total	119	3.4807	1.00537	1	6
Pharmacy	Early Program	42	2.4365	1.20408	1	6
	Middle Program	33	2.8081	1.02750	1	6
	Late Program	44	2.4470	1.37708	1	6
	Total	119	2.5434	1.22810	1	6
Industry	Early Program	42	3.9603	1.52166	1	6
	Middle Program	33	4.3030	1.03200	1	6
	Late Program	44	3.6742	1.40411	1	6
	Total	119	3.9496	1.36932	1	6
Knowledge	Early Program	42	3.6746	1.07821	1	6
	Middle Program	33	3.5657	.96640	1	6
	Late Program	44	3.2652	1.01813	1	6
	Total	119	3.4930	1.03320	1	6
Physician	Early Program	42	3.1905	1.51799	1	6
	Middle Program	33	3.3030	1.38033	1	6
	Late Program	44	3.0000	1.49417	1	6
	Total	119	3.1513	1.46507	1	6

Latent Factors Based on Reason's Model						
Personal	Early Program	42	3.9762	.98744	1	6
	Middle Program	33	3.7576	.91105	1	6
	Late Program	44	3.6364	.93262	1	6
	Total	119	3.7899	.94666	1	6
Human Engineering	Early Program	42	3.7440	1.38534	1	6
	Middle Program	33	4.0000	.89704	1	6
	Late Program	44	3.5341	1.14449	1	6
	Total	119	3.7374	1.18198	1	6
Organizational Safety	Early Program	42	3.0298	.92097	1	6
	Middle Program	33	3.2795	.65988	1	6
	Late Program	44	2.9318	.80399	1	6
	Total	119	3.0628	.81748	1	6

Table 4.4

Differences of Hogan's Five Factors According to Level of Student Taught

	Systems	Pharmacy	Industry	Knowledge	Physician
Kruskal-Wallis	.957	2.963	3.470	3.049	.750
df	2	2	2	2	2
Sig	.620	.227	.176	.218	.687

Table 4.5

Differences of Reasons Three Factors According to Level of Student Taught

	Personal	Human Engineering	Organizational safety
Kruskal-Wallis	3.177	3.107	3.748
df	2	2	2
sig	.204	.212	.153

Question four: Do undergraduate nursing clinical instructors report differences in frequency of medication errors and near-misses based upon level of student taught? The hypothesis of this research question is that there is a statistically significant difference in the number of medication errors and near-misses reported by undergraduate nursing clinical instructors based upon level of student taught. Clinical instructors were asked to report the number of medication errors that occur over the course of a clinical and the number of near-misses that occur each clinical day. Findings indicate that 85 (71.4%) of clinical instructors report zero to five near-misses each clinical day, and 51 (42.9%) report zero to five medication errors over the course of a clinical. One instructor noted that "there are near-misses all the time, but I stop the student prior to administration" (see Table 4.6). No significant difference was found on the effect of level of student taught on the number of errors and the hypothesis was rejected (see Tables 4.7 and 4.8). In addition, no significant difference was found on the effect of level of student taught on the number of near-misses thus, the hypothesis was rejected (see Tables 4.9 and 4.10).

Table 4.6

Reported Number of Medication Errors and Near-Misses

Number of Near-Misses	Frequency	Percentage
None	29	24.4
0 – 5	85	71.4
5 – 10	1	0.8
Other	4	3.4
Number of Errors		
None	55	46.2
0 - 5	51	42.9
5 - 10	5	4.2
Other	8	6.7

Table 4.7

Number Errors Based on Level of Student Taught

	Level Teach	N	Mean Rank
Number Errors	Early Program	42	62.46
	Middle Program	33	53.14
	Late Program	44	62.80
	Total	119	

Table 4.8

Difference of Number Errors Based on Level of Student Taught

	Number Errors
Kruskal-Wallis	2.201
Df	2
Sig	.333

Table 4.9

Number Near-Misses Based on Level of Student Taught

	Level Teach	N	Mean Rank
Number Misses	Early Program	42	59.99
	Middle Program	33	53.00
	Late Program	44	65.26
	Total	119	

Table 4.10

Difference of Number Near-Misses Based on Level of Student Taught

	Number Near-Misses
Kruskal-Wallis	3.836
Df	2
Sig	.147

Question five: The top three strategies used to prepare students to safely manage medications as identified by the clinical instructor are clinical group (92.4%), simulated clinical experience (75.6%), and laboratory course (62.2%) (see Table 4.11). The top three settings identified by clinical instructors in which medication management content is taught are simulation lab (78.2%), clinical lab (77.3%), and clinical agency (77.3%) (see Table 4.12).

Question six: The top three activities and equipment used to prepare prelicensure nursing students to safely manage medication are basic equipment such as med cups, syringes, pill cutter, and medicine cart were the most common 113 (95%), followed by partial task trainers such as injection pads, injection buttocks, and IV arms 90 (75.6%), and electronic health record (EHR) 83 (69.7%) (see Table 4.13).

Table 4.11

Strategies used to Prepare Nursing Students

Teaching strategies used to prepare students	*n* (%)
Clinical group with some one-to-one with faculty	110 (92.4)
Simulated clinical experience (any type of simulation)	90 (75.6)
Lab course, e.g., one teacher with a group of students	74 (62.2)
Lecture	71 (59.7)
Computer/web-based assignment	54 (45.4)
Staff nurse preceptor one-to-one with student	51 (42.9)
Problem-based learning	32 (26.9)
Tutorial, e.g., lab setting with one teacher and one or two students	25 (21)
Other	6 (5)

Table 4.12

Setting in Which Medication Management Taught

Setting in which medication management taught	*n* (%)
Simulation Room/Center	93 (78.2)
Clinical Agency	92 (77.3)
Clinical Laboratory	92 (77.3)
Classroom	85 (71.4)
Other	11 (9.2)

Question seven: Clinical instructors were also asked if there were any educational activities that would enhance the safety of undergraduate nursing student medication safety. One instructor recommended distraction training. Another recommendation is to use similar equipment on campus that is available at clinical sites, including EMR and scanning. Others

recommended videotaping and grading or high stakes testing. Several instructors commented on students relying on the scanning of the medication without thinking of the implications of administering the medications. One stated, “I think that in the beginning they should have to write out the steps they use. They are so used to clicking the next step that they are not aware of the importance of each one”.

Table 4.13

Activities and/or Equipment Used to Prepare Nursing Students

Activities and/or Equipment used to prepare students	*n* (%)
Basic equipment, e.g., medicine cups, syringes, pill cutter, medicine cart	113 (95)
Partial task trainers, e.g., injection pads, injection buttocks, IV arms	90 (75.6)
Electronic health record (EHR)	83 (69.7)
Computer-based programs, e.g., dosage calculation, clinical scenarios, virtual hospital	81 (68.1)
Barcode scanner	77 (64.7)
Electronic medication dispensing cart/machine	75 (63)
Smart infusion devices, e.g., Alaris IV pump with drug database	74 (62.2)
Full-body simple manikin	51 (42.9)
Full-body high-fidelity manikin (life-like computerized manikin)	50 (42)
Full-body medium-fidelity manikin (some basic electronics)	37 (31.1)
Peer patients (other students in class)	27 (22.7)
Computer-based task trainers, e.g., IV trainer with haptic feedback	14 (11.8)
Standardized patients (trained, live patient actors)	11 (9.2)
Virtual reality systems, e.g., computerized system with headset and/or gloves	10 (8.4)
Other	2 (1.7)

Discussion

The individual contributing factors of medication errors and near-misses identified were 'students have limited knowledge about medications,' 'the names of many medications are similar,' 'all medications for one team of patients cannot be passed within an accepted time frame,' 'the packaging of many medications is similar,' and 'students do not receive enough instruction on medications'. Of the five latent factors, systems, pharmacy, and industry were the top 3 identified.

A content analysis was completed on the open-ended questions in order to describe the factors identified. Themes identified included 'not enough practice', 'not understanding medication rights', and 'familiarity with equipment'. The themes and contributing factors identified confirm that students are not getting the experience needed.

There were no significant differences found in the number of errors and near-misses based upon the level of student taught, indicating the problem is universal and should be anticipated, and strategies to mitigate errors must be integrated into the curriculum. It was anticipated that clinical instructors teaching later in the program would report fewer errors and near-misses. Schneidereith (2014) reported a statistically significant difference between first-semester senior students and second-semester seniors in the verification of the rights of medication administration. Only 50% of the first-semester seniors and none of the second-semester seniors verified all or any of the medication rights. Students at all levels are vulnerable to errors, and strategies must be implemented across the entire program.

Nurses play a pivotal role in the safe administration of medications, and learning how to do so begins in nursing school. The entire medication administration process is complex and occurs within a dynamic environment. Students must integrate the acquired knowledge of the

skill itself with the cognitive aspects in an environment they are unfamiliar with. Multiple respondents voiced concern regarding the environment the students learn in versus the clinical environment. Suggestions to improve the education of the process included utilizing similar equipment in the laboratory, including medication dispensing systems, scanners, and even multiple patient loads in simulation with interruptions built-in to increase the complexity. According to Bransford et al. (1999), proficiency in the use of relevant equipment may enhance the transfer of knowledge from the laboratory to the clinical site. Structured learning opportunities, along with facilitated practice, should reflect real-world practice. Precision can decrease the factors that interfere with working memory, which may enhance focus on the cognitive aspects of the process. Benner et al. (2010) identified that the clinical learning environment is important in the development of clinical reasoning and increasing patient safety.

Several instructors suggested a return to the basics. One respondent stated, "the pharmacy prepares and sends almost everything dose ready so when they (the students) are presented with a problem to solve, they have very little experience." This same respondent stated, "I love technology, but not as a replacement for thinking." Another stated, "our students are becoming more likely to scan and go rather than analyze the safety of giving the drug." Technological advancements such as electronic medication dispensing systems, electronic medication administration records, and barcode scanning have all been designed to increase patient safety. In an article by Krautscheid et al. (2011), nurses have come to rely on those systems. In a study by Stetina et al. (2005), participants reported that the medication dispensing system would catch any errors.

Krautscheid et al. (2011) did a qualitative study in which nursing students reported needing education on how to manage real-world situations, distractions, etc. and how to manage

the alerts embedded within the technology. Students reported not understanding what the alerts mean, when they should resolve them, and how they resolve them. In 2007 Cronenwett et al. stated that it takes time and formative feedback in order for students to properly learn how to manage healthcare technology and develop the knowledge, skills, and attitudes that promote safety.

Summary

Reduction of medication administration errors is the key to improving patient safety in healthcare. Errors can occur at any step within the medication administration process; however, it is the nurses at the sharp end of the error and the final stop before it reaches the patient. Nurse educators must examine how the process is taught and use the evidence to improve that process.

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CHAPTER 5

SYNTHESIS

INTRODUCTION

This study investigated the perceptions of undergraduate nursing clinical instructors of the factors contributing to students' medication administration errors and near-misses.

Synthesis of the Study

This dissertation is composed of five chapters. Three articles have been prepared for publication and integrated into the chapters. Chapter 1 provides the statement of the problem and its relation to nursing. Definitions of medication errors and near-misses are also explored, and the definitions used in the study are presented. The various categories of medication errors, as provided by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP), are also discussed. James Reasons' *Swiss cheese model of accident causation* and human error theory provides the conceptual framework for investigating student medication errors and near-misses. Chapter two is a manuscript of the literature review. The literature review covers 71 articles from peer-reviewed journals from 2006 to 2020. The articles were divided into four themes: barriers to reporting errors, solutions or strategies for reducing the number of errors, medication calculations, and contributing factors of medication administration errors. Some articles fit more than one theme, and a total of seven articles investigated students and new graduates that did not fit into one of the identified themes. The chapter highlights the gap in the literature regarding the examination of medication errors and near-misses in undergraduate and new graduate nurses. Chapter three focuses on the methodology of the study. The research design, instrumentation, sample population, data collection methods, and data analysis plan are all covered. Chapter four is a manuscript covering the results of the study and the statistical

analysis used. The dissertation concludes with chapter five, presenting a synthesis of the study and the manuscripts. The third manuscript in chapter five proposes implications for nursing education and policy. The chapter presents the contributing factors to nurses and student nurses medication errors and near-misses found in the literature, the prevention strategies that are in place, and

Gap in Nursing Knowledge

There is a gap in nursing knowledge specific to medication safety in nursing education, particularly the contributing factors to medication errors and near-misses in undergraduate nursing students. While nursing education does teach the process of medication administration, its focus is on the procedural aspects of the medication rights, which includes right patient, right medication, right dose, right route, and right time as well as medication dose calculations. Despite educational opportunities in the classroom and laboratory, medication errors and near-misses in undergraduate nursing students and new graduate nurses continue to be an issue (Latimer et al., 2017; Mariani et al., 2017; Schneidereith, 2014). Literature exists on the contributing factors to medication errors for nurses; however, there is a paucity of literature related to students and new graduates. Only one article was identified that utilized the instructors' perceptions, and that was to develop a medication error reporting form (Emerson et al., 2019).

Summary of Study Findings

Study findings indicate clinical instructors perceive the top 5 most common contributing factors of medication errors and near-misses to be 'students have limited knowledge about medications,' 'the names of many medications are similar,' 'all medications for one team of patients cannot be passed within an accepted time frame,' 'the packaging of many medications is

similar,' and 'students do not receive enough instruction on medications.' A content analysis was done on the open-ended questions to understand how instructors describe the contributing factors, and overwhelmingly, instructors noted that students do not understand the medication rights and are unfamiliar with the equipment and the environment. The factors identified were investigated to see if they differed by the level of student taught. The factors investigated were the five factors identified in the exploratory factor analysis done by Hogan in 2006 on the Medication Administration Error Survey (MAE survey); physician, systems, pharmacy, industry, and knowledge. No significant difference was found on the factors identified based upon the level of student. Similarly, no significant difference was found on the number of errors and near-misses reported based on the level of the student taught. The top three strategies used to prepare students to safely manage medications as identified by the clinical instructor are clinical group, simulated clinical experience, and laboratory course. The top three activities and equipment used to prepare prelicensure nursing students to safely manage medication include basic equipment such as med cups, syringes, pill cutter, and medicine cart, followed by partial task trainers such as injection pads, injection buttocks, and IV arms, the use of an electronic health record (EHR). Finally, instructors were asked to identify activities that would improve nursing student medication management. Most recommendations included activities that incorporate the equipment and environment of the healthcare setting into their learning activities, giving them a more realistic hands-on experience.

Synthesis of the Manuscripts

The first manuscript, *Literature Review of Medication Errors and Near-Misses in Undergraduate Nursing Students and the Factors that Contribute to them* is proposed to be submitted to *Teaching and Learning in Nursing* and follows its guidelines for authors. The

purpose of the manuscript was to perform a literature review to identify gaps in the nursing knowledge of medication errors and near-misses in undergraduate nursing students. Inconsistencies in the measurement of perceptions make comparisons difficult, and there is a paucity of literature focusing on undergraduate nursing students.

The second manuscript, *The Perceptions of Undergraduate Prelicensure Clinical Instructors on the Contributing Factors to Medication Error and Near-Misses of Nursing Students,* is proposed to be submitted to *Nurse Educator* and follows its guidelines for authors. The purpose is to describe the findings of the study and how the findings address the gap in the literature. Suggested activities to address the factors identified were also discussed.

The final manuscript, *The Future of Nursing Education: Impacting Medication Administration Safety,* is proposed to be submitted to the *Journal of Nursing Education* and follows its guidelines for authors. The purpose is to address the contributing factors of medication errors found in the literature and propose future research potential.

Future Research

The study results indicate that limited opportunities to practice medication administration in the clinical setting contribute to errors and near-misses. Limited practice leads to a lack of familiarity with the equipment as well as the environment. Nursing education is responsible for ensuring that graduates of nursing programs understand the process and can administer medications safely. Strategies to replicate the clinical environment should be incorporated regularly to ensure students get repeated opportunities to develop the skills needed. Simulation can provide a safe environment that can mimic the clinical setting. The incorporation of electronic medication dispensing systems, electronic Medication Administration Records (eMARs), scanning equipment, smart IV pumps, and some of the common environmental factors

such as distractions can provide the students with the practice needed to synthesize the skills acquired within the context of the clinical environment.

Future research is also needed to expand the knowledge base of prelicensure student nurse medication errors, the types, and the specific contributing factors. Implementation of policies and reporting forms to collect this information can inform nursing education programs and assist in the identification of gaps in curriculum and institutional policies.

Limitations

The findings of this study have several limitations. The study was conducted in one midwestern state and may not be generalizable to other states. Another potential limitation is the potential for response bias. Respondents may have provided what they consider socially acceptable responses or adjusted their responses to please the researcher.

The survey format, utilizing Qualtrics, may have also created a limitation by limiting those unfamiliar with the software.

The final limitation is the limitation of the tool used in the study, the MAE Survey. The tool lacked some of the contributing factors that were identified by the clinical instructors in the open-ended questions, such as calculation errors and issues with the nurse preceptors.

Policy

This study provides evidence of the factors that contribute to student nurse medication errors and near-misses from the perspective of clinical instructors. Furthermore, it indicates a lack of clarity of the definitions of medication errors and near-misses and the value of collecting that data. The results also indicate a large degree of variation in the methods used to teach medication administration in the clinical setting. Some instructors noted they never experienced a near-miss with a student, while others noted that they occur all the time, but they intervene

before it reaches the patient, indicating not only a lack of understanding of what defines a near-miss but also indicates not recognizing the value of allowing students to experience near-misses. Simulation can allow the students to practice medication administration in a realistic environment and without instructor prompting.

Simulation programs in higher education need to be supported through sufficient state budgeting for the universities within our system. Further cuts in state appropriations will have devastating effects on the ability of nursing faculty to provide the experiences needed for our schools to graduate safe, competent nurses. To prepare safe and competent nurses for our healthcare system, adequate funding is needed to ensure the expertise required to operate simulation labs. It is imperative to provide professional development opportunities for nursing faculty to provide simulation using best practices. In a time of clinical placement difficulties, simulation can be utilized to bridge the gap. With adequate opportunities and education, patient outcomes regarding medication safety will improve.

Manuscript Three: The Future of Nursing Education: Impacting Medication Administration Safety

Kristen M. Selig, MS, RN

University of Wisconsin - Milwaukee

Abstract

Nursing education programs are challenged to keep up with the dynamic and changing environment of the healthcare system. Literature shows that prelicensure nursing students and practicing nurses are both struggling to manage medication administration safely in the context of the clinical environment. Traditionally, medication administration has been taught using the medication rights: right patient, right medication, right dose, right route, and right time. With the increasing complexity of the healthcare system, education needs to move beyond the rights.

Introduction

The landmark report *To Err is Human,* from the Institute of Medicine (IOM) raised public awareness and called attention to the quality of healthcare and patient safety (IOM, 2000). Quality and Safety Education for Nurses (QSEN) was developed in response to bridge the gap between nursing education and practice. The project was developed in three phases, with phase I bringing together a group of experts to examine the factors that impact quality and safety. During phase I, targets were proposed for the knowledge, skills, and attitudes (KSA's) that need to be developed in undergraduate nursing education programs for each of the competencies identified, which include: patient-centered care, teamwork and collaboration, evidence-based practice, quality improvement, safety, and information (QSEN, 2005). Medication safety remains a significant problem in healthcare. In undergraduate nursing education, the focus is often on the

procedural methods of medication administration, such as the medication rights, without consideration of the system within which it occurs.

Background

At least 25% of all medication errors are preventable (IOM, 2007). Errors occur in hospitals during all steps of the medication use process, which includes procuring the drug, prescribing, dispensing, administering, and monitoring the patient's response (IOM, 2007). The most frequent occurrences are during the prescribing and administration stages (IOM, 2007). Nurses are responsible for this final phase, which includes administering medications and monitoring for effectiveness and side effects. Nurses are the final check in the administration phase and catch up to 70% of errors before they occur (Bates, 2007). There is no other professional to intervene before administering medications, and reports have suggested that nurses are responsible for up to 38% of medication errors (Bates, 2007).

The Institute of Safe Medication Practice (ISMP) (2013) reports that in 2011 there were 30,725 deaths related to medication errors. In 2012 there was a 47.8% increase to 45,421 deaths related to medication errors (ISMP, 2013). The 2010 National Healthcare Quality Report from the Agency for Healthcare Research and Quality (AHRQ) estimates between 44,000 and 98,000 Americans die each year from medical errors. It is also estimated that the rate of adverse drug events during hospital admissions is between 2.0% and 6.7% (AHRQ, 2011). Medical errors are costly, both in terms of personal distress and economic cost. Preventable medical errors can exact significant tolls, including the loss of human life. It is estimated that the financial cost of medical errors is between 17 billion dollars and 29 billion dollars when considering the expense of additional care necessitated by the errors (IOM, 2000).

Medication administration is an essential nursing skill that consists of a complex series of steps necessary to administer medications safely and without errors (Boxer & Kluge, 2000). Errors during the medication administration process are the most common and fatal errors in the profession (Brady et al., 2009). There are a variety of causes of medication errors by nurses. Those include failure to follow the medication rights, nursing incompetence, distractions, interruptions, inadequate staffing, incorrect dosage calculations, similar drug names or packaging, and failure to ID patient (Cloete, 2015). Despite multiple improvements in technology and processes, errors continue to exist. Factors influencing the challenges that faculty face in educating students about the process of medication administration include providing students with sufficient authentic experiences to practice safely.

There is much literature to support the challenges that nursing educators face in providing students with sufficient knowledge and practicum experience to adequately learn the foundational skills necessary for safe medication administration (Cooper, 2014; Harding & Petrick, 2008; Wolf et al., 2006). Nurse educators must address the risk that medication administration poses to patients. Students are expected to graduate with the competence to administer medications safely. Education regarding medication administration has to go beyond the "medication rights" to prepare students to practice safely. The use of simulation, in addition to traditional approaches to education has the potential to impact competency development, patient care, patient safety, and change behavior (Lopez, 2017).

Contributing Factors

The contributing factors to medication administration errors reported in the literature are the same for practicing nurses as they are for students and include distractions and interruptions (Al-Otaibi, 2018; Alomari, 2018; Armutlu et al., 2008; Cohoon, 2011; Deans, 2005; Härkänen et

al., 2018; Jones & Treiber, 2010; Mrayyan et al., 2007; Petrova et al., 2010; Salami et al., 2019; Sessions et al., 2019; Suclupe et al., 2019; Treiber & Jones, 2018; Wolf et al., 2006), inexperience (Alharbi, 2019; Basil et al., 2019; Cohoon, 2011; Davis et al., 2005; Deans, 2005; Jones & Treiber, 2010; Kim et al., 2011; Salami et al., 2019; Treiber & Jones, 2018; Treiber & Jones, 2012; Wolf et al., 2006), lack of following procedure/protocol (Alomari, 2018; Armutlu et al., 2008; Cohoon, 2011; Davis et al., 2005; Hicks & Becker, 2006; Jones & Treiber, 2010; Kim et al., 2011; Musharyanti et al., 2019; Salami et al., 2019; Sessions et al., 2019; Stetina et al., 2005; Svitlica et al., 2017; Treiber & Jones, 2012; Wolf et al., 2006), knowledge deficit (Al-Otaibi, 2018; Armutlu et al., 2008; Deans, 2005; Fathi et al., 2017; Härkänen et al., 2018; Jones & Treiber, 2010; Musharyanti et al., 2019; Petrova et al., 2010; Salami et al., 2019; Svitlica et al., 2017; Treiber & Jones, 2018; Treiber & Jones, 2012; Vaismoradi et al., 2014; Wolf et al., 2006), and lack of communication (Alharbi, 2019; Cohoon, 2011; Deans, 2005; Hicks & Becker, 2006; Kim et al., 2011; Petrova et al., 2010; Svitlica et al., 2017; Wolf et al., 2006). The contributing factors of fatigue and staffing issues are found in practicing nurses, but not in the student nurses.

While some contributing factors can be related to the person, many are systems factors such as distractions and interruptions, staffing/workload, and lack of communication. The ability to make accurate choices is associated with multiple factors that include the knowledge base and system factors, availability of information, workload, and barriers to innovation (Ebright, 2003). The context in which medications are administered and the system factors must be addressed in nursing education.

Prevention Strategies

Since the 2000 IOM report, various technologies have been implemented to reduce medication administration errors, including computerized prescriber order entry systems, automated dispensing cabinets, smart infusion pumps, barcode-assisted medication administration systems, and eMARs. Each of the technologies implemented has advantages and disadvantages and is only as good as the technology user. The technology is not meant to replace the basics of medication administration, such as the medication rights. Too much reliance on technology may decrease the use of crucial safety steps such as the medication rights.

Workarounds have received attention in the literature related to technology designed to improve medication safety. In a study by van der Veen et al. (2018), it was discovered that more than two-thirds of the drug administrations observed, the barcode medication technology was not used as intended and increased the risk of errors. According to Kobayashi et al. (2005), workarounds were defined as an "informal temporary practice for handling exceptions to normal workflow." The contributing factors to workarounds, according to van der Veen et al. (2018), were not following procedures such as not scanning, issues with the patient wristband, the medication scanning such as no barcode, computer or scanner issues, nurse workflow such as distractions, and other issues such as missing medications.

Implications for Nursing Education

A focus on patient safety education in undergraduate nursing programs needs to begin early to produce competent nurses in patient safety (Robson, 2009). This makes it challenging for nurse educators to ensure that the practices that promote medication safety are integrated throughout the curriculum. While it is important to ensure students' utilization of the medication rights and medication calculations, it cannot stop there.

Traditionally medication administration is taught in the classroom, the laboratory, and the traditional clinical setting. The experiences in the clinical setting are varied across healthcare institutions. There are several reasons why traditional clinical experiences are not providing the opportunities needed to reinforce the knowledge and skills needed to learn medication administration. Concern for patient safety is of utmost importance, and competition for clinical sites and restrictions on utilization of the eMARs decreases the opportunity for students to experience the full complexity of the medication administration process. Simulation allows students to practice safe medication administration steps in an environment that mimics the clinical setting without risk of harm to the patients. Strong evidence links simulation to improved learning outcomes, which ultimately leads to risk reduction and increased patient safety (Aebersold & Tschannen, 2013; Theilen et al., 2012; Shea-Lewis, 2009; Riley et al., 2011; Phipps et al., 2012; Andreatta et al., 2011).

The contributing factors identified in the literature for both practicing nurses and undergraduate prelicensure nurses indicate that more attention needs to be paid to the complexity of the healthcare environment within which medication administration occurs. Teaching strategies situated in realism and context-laden environments need to be provided to prelicensure nurses to prepare for the practice environment. Students need to be prepared to administer medications safely in the context of the clinical setting with all of the equipment, interruptions, and alarms they will encounter in practice. Teaching must go beyond just the medication rights.

Schools of nursing should have a clear definition of a medication error and a near-miss with processes in place to track the data. Students are most often supervised while administering medications, and therefore, information on near-misses can be just as valuable as information on errors. Disch et al. (2017) conducted a study in which 55% of nursing schools surveyed in the

United States replied no when asked if their school had a tool for reporting errors. When asked if their school differentiated between the occurrence of an error versus a near-miss, only 20% said yes. Interestingly, in this same study, multiple respondents believed that their students are not committing errors due to the expertise of the clinical instructors. Whether or not this is true is irrelevant. It does not consider the near-misses that must be occurring and the value of that information. Medication safety and error reporting need to be included when teaching the process of medication administration. Including this throughout the curriculum would heighten student awareness of errors and near-misses. Moreover, students reporting errors and near-misses may help to reduce the fear of error reporting. Recording, tracking, and analyzing the errors will also provide the program with valuable information that can be used to evaluate the curriculum and improve student outcomes.

Future Research

Further research is needed to evaluate the effectiveness of simulation to teach medication administration safety and evaluate the effectiveness of teaching the use of medication technology in the simulated setting and the transfer of knowledge to practice.

Conclusion

The enormity of medication errors was brought to the public's attention in 2000 with the IOM report *To Err is Human.* Since then, despite the progression of technology use to reduce the number of medication errors, the problems persist. Patient safety needs to be addressed in prelicensure education. The responsibility lies not only with the educators but also with the clinical agencies and accrediting bodies. Efforts should be data-driven and begin with the collection and analysis of safety data.

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Summary

This study provided evidence that the factors that contribute to student nurse medication errors include unfamiliarity with the clinical environment and the technology used during the medication administration process. Nurse educators need to address the risk that medication administration poses to our patient population. Future research should be directed at identifying the gaps within the curriculum that address these factors and in developing teaching strategies to support students' acquisition of the knowledge, skills, and attitudes required for the safe administration of medication.

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Appendix A

Demographics

The following questions address the program that you teach clinical for:

1. What program(s) do you have that lead to initial licensure as a registered nurse? Select all that apply. (program)

- ❑ Associate degree
- ❑ Bachelor's degree

2. Does your academic organization have an official definition of a medication error? (definition)

- ❍ Yes
- ❍ No
- ❍ Not sure

If possible, please copy and paste your organization's medication error definition in the box below. If you cannot access a copy of the definition right now, please continue on to the next question.

3. How many years of practicing nursing experience do you have?

_____

4. How many years of clinical teaching do you have?

_____

5. Do you teach in more than 1 level of the nursing program?

Yes____ No____
If yes:
Statement will appear that "you are answering these questions based on one of the levels that you teach". At the end a second questionnaire will appear with the statement "you are answering these questions based on the other level of students you teach".

6. What is the level of student that you teach clinical for?

- ❍ Early Program (First 1/3 nursing program)
- ❍ Middle Program (Middle 1/3 nursing program)
- ❍ Late Program (Final 1/3 nursing program)

In order to obtain information about what your students experience when learning safe medication management (preparation, administration, & monitoring), think about how prelicensure nursing students in your program are educated when answering the following questions.

7. In what setting(s) is medication management content taught to your prelicensure RN students (not just reinforced from previous courses)? Select all that apply.

- ❑ Classroom
- ❑ Clinical laboratory
- ❑ Simulation room/center
- ❑ Clinical agency
- ❑ Other (Please specify): _____

8. What teaching strategies do you use to prepare prelicensure nursing students to safely manage medications (prepare, administer, & monitor)? Select all that apply.

- ❑ Lecture
- ❑ Lab course, e.g., one teacher with a group of students
- ❑ Tutorial, e.g., lab setting with one teacher and one or two students
- ❑ Clinical group with some one-to-one with faculty
- ❑ Staff nurse preceptor one-to-one with student
- ❑ Problem-based learning
- ❑ Simulated clinical experience (any type of simulation)
- ❑ Computer/web-based assignment
- ❑ Other (Please specify): _____

9. What activities and/or equipment do you use to prepare prelicensure nursing students to safely manage medications (prepare, administer, & monitor)? Select all that apply.

- ❑ Basic equipment, e.g., medicine cups, syringes, pill cutter, medicine cart
- ❑ Partial task trainers, e.g., injection pads, injection buttocks, IV arms
- ❑ Computer-based programs, e.g., dosage calculation, clinical scenarios, virtual hospital
- ❑ Computer-based task trainers, e.g., IV trainer with haptic feedback
- ❑ Virtual reality systems, e.g., computerized system with headset and/or gloves
- ❑ Full-body simple manikin
- ❑ Full-body medium-fidelity manikin (some basic electronics)
- ❑ Full-body high-fidelity manikin (life-like computerized manikin)
- ❑ Standardized patients (trained, live patient actors)
- ❑ Peer patients (other students in class)
- ❑ Electronic health record (EHR)
- ❑ Electronic medication dispensing cart/machine
- ❑ Bar-code scanner
- ❑ Smart infusion devices, e.g., Alaris IV pump with drug database
- ❑ Other (Please specify): _____

10. How is the medication management competency of your prelicensure nursing students assessed? Select all that apply.

- ❑ Paper and pencil test
- ❑ Computer-based test (similar to paper and pencil test)
- ❑ Computer scenario-based test
- ❑ Simulated clinical experience evaluation
- ❑ Clinical faculty evaluation
- ❑ Other (Please specify): _____

11. On average, how many near misses do you catch each clinical day?

- ❑ None
- ❑ 0 - 5
- ❑ 5 – 10
- ❑ Other (Please specify): _____

12. On average, how many medication errors occur over the course of clinical?

- ❑ None
- ❑ 0 - 5
- ❑ 5 – 10
- ❑ Other (Please specify): _____

13. Are there any educational activities you think would enhance the safety of undergraduate nursing student medication safety?

14. Is there any other information you would like to share with us about how you educate prelicensure nurses about safe medication management? If so, please enter your comments here

Appendix B

Medication Administration Error Survey

The purpose of this survey is to seek input, based on your clinical experience, from the head and staff nurses on the occurrence and reporting of medication administration errors and the extent to which errors are reported on your unit. This survey will take approximately 5 - 10 minutes to complete. All responses will be kept strictly confidential. Thank you for your time and cooperation!

Definition of Medication Administration Errors (MAEs): For the purposes of this survey, MAEs are defined as errors related to the actual ingestion, injection or application of individual medication doses (e.g., wrong method of administration, wrong patient, wrong additive).

A. Reasons Why Medication Errors Occur On Your Unit. Please circle the number that best reflects the extent to which you agree that the following reasons contribute to <u>why medication errors occur on your unit.</u>

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
1. The names of many medications are similar.	1	2	3	4	5	6
2. Different medications look alike.	1	2	3	4	5	6
3. The packaging of many medications is similar.	1	2	3	4	5	6
4. Physicians' medication orders are not legible.	1	2	3	4	5	6
5. Physicians' medication orders are not clear.	1	2	3	4	5	6
6. Physicians change orders frequently.	1	2	3	4	5	6
7. Abbreviations are used instead of writing the orders out completely.	1	2	3	4	5	6
8. Verbal orders are used instead of written orders.	1	2	3	4	5	6
9. Pharmacy delivers incorrect doses to this unit.	1	2	3	4	5	6
10. Pharmacy does not prepare the med correctly.	1	2	3	4	5	6
11. Pharmacy does not label the med correctly.	1	2	3	4	5	6

12. Pharmacists are not available 24 hours a day.	1	2	3	4	5	6
13. Frequent substitution of drugs (i.e., cheaper generic for brand names).	1	2	3	4	5	6

	Strongly Disagree	**Moderately Disagree**	**Slightly Disagree**	**Slightly Agree**	**Moderately Agree**	**Strongly Agree**
14. Poor communication between nurses and physicians.	1	2	3	4	5	6
15. Many patients are on the same or similar medications.	1	2	3	4	5	6
16. Unit staff do not receive enough inservices on new medications.	1	2	3	4	5	6
17. On this unit, there is no easy way to look up information on medications.	1	2	3	4	5	6
18. Nurses on this unit have limited knowledge about medications.	1	2	3	4	5	6
19. Nurses get pulled between teams and from other units.	1	2	3	4	5	6
20. When scheduled medications are delayed, nurses do not communicate the time when the next dose is due.	1	2	3	4	5	6
21. Nurses on this unit do not adhere to the approved medication administration procedure.	1	2	3	4	5	6
22. Nurses are interrupted while administering medications to perform other duties.	1	2	3	4	5	6
23. Unit staffing levels are inadequate.	1	2	3	4	5	6
24. All medications for one team of patients cannot be passed within an accepted time frame.	1	2	3	4	5	6
25. Medication orders are not transcribed to the Kardex correctly.	1	2	3	4	5	6
26. Errors are made in the Medication Kardex.	1	2	3	4	5	6
27. Equipment malfunctions or is not set correctly (e.g., IV pump).	1	2	3	4	5	6
28. Nurse is unaware of a known allergy.	1	2	3	4	5	6
29. Patients are off the ward for other care.	1	2	3	4	5	6

B. Reasons Why Medication Administration Errors Are Not Reported On Your Unit. Please circle the number that best reflects the extent to which you agree that the following reasons contribute to why errors are not reported on your unit.

	Strongly Disagree	Mod. Disagree	Slightly Disagree	Slightly Agree	Mod. Agree	Strongly Agree
30. Nurses do not agree with hospital's definition of a medication error.	1	2	3	4	5	6
31. Nurses do not recognize an error occurred.	1	2	3	4	5	6
32. Filling out an incident report for a medication error takes too much time.	1	2	3	4	5	6
33. Contacting the physician about a medication error takes too much time.	1	2	3	4	5	6
34. Medication error is not clearly defined.	1	2	3	4	5	6
35. Nurses may not think the error is important enough to be reported.	1	2	3	4	5	6
36. Nurses believe that other nurses will think they are incompetent if they make medication errors.	1	2	3	4	5	6
37. The patient or family might develop a negative attitude toward the nurse, or may sue the nurse if a medication error is reported.	1	2	3	4	5	6
38. The expectation that medications be given exactly as ordered is unrealistic.	1	2	3	4	5	6
39. Nurses are afraid the physician will reprimand them for the medication error.	1	2	3	4	5	6
40. Nurses fear adverse consequences from reporting medication errors.	1	2	3	4	5	6
41. The response by nursing administration does not match the severity of the error.	1	2	3	4	5	6
42. Nurses could be blamed if something happens to the patient as a result of the medication error.	1	2	3	4	5	6
43. No positive feedback is given for passing medications correctly.	1	2	3	4	5	6
44. Too much emphasis is placed on med errors as a measure of the quality of nursing care provided.	1	2	3	4	5	6
45. When med errors occur, nursing administration focuses on the individual rather than looking at the systems as a potential cause of the error.	1	2	3	4	5	6

C. Percentage of Each Type of Error Reported on Your Unit. Based on your experience, please circle the number that best represents what percentage of each type of medication error you believe is actually reported on your unit.

	Percentage Reported									
Types of Non-IV Medication Errors	0 - 20	21- 30	31- 40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 - 99	100
46. Wrong route of administration	1	2	3	4	5	6	7	8	9	10
47. Wrong time of administration	1	2	3	4	5	6	7	8	9	10
48. Wrong patient	1	2	3	4	5	6	7	8	9	10
49. Wrong dose	1	2	3	4	5	6	7	8	9	10
50. Wrong drug	1	2	3	4	5	6	7	8	9	10
51. Medication is omitted	1	2	3	4	5	6	7	8	9	10
52. Medication is given, but has not been ordered by the physician	1	2	3	4	5	6	7	8	9	10
53. Medication administered after the order to discontinue has been written	1	2	3	4	5	6	7	8	9	10
54. Given to patient with a known allergy	1	2	3	4	5	6	7	8	9	10
Types of IV Errors										
55. Wrong method of administration	1	2	3	4	5	6	7	8	9	10
56. Wrong time of administration	1	2	3	4	5	6	7	8	9	10
57. Wrong patient	1	2	3	4	5	6	7	8	9	10
58. Wrong dose	1	2	3	4	5	6	7	8	9	10
59. Wrong drug	1	2	3	4	5	6	7	8	9	10
60. Medication is omitted	1	2	3	4	5	6	7	8	9	10
61. Medication is given, but has not been ordered by the physician	1	2	3	4	5	6	7	8	9	10
62. Medication administered after the order to discontinue has been written	1	2	3	4	5	6	7	8	9	10

63. Given to patient with a known allergy	1	2	3	4	5	6	7	8	9	10
64. Wrong fluid	1	2	3	4	5	6	7	8	9	10
65. Wrong rate of administration	1	2	3	4	5	6	7	8	9	10

Based on your experience, what percentage of all types of medication errors, including IV and non-IV medication errors are actually reported on your unit (please circle one)

0 - 20% 21 - 30% 31 - 40% 41 - 50% 51 - 60% 61 - 70% 71 - 80% 81 - 90% 91 - 99% 100%

To assist in data analysis and interpretation of the survey results, we would appreciate if you would provide us with the following information--Please circle the number that best represents you and your unit.

67. Does your nursing unit use the unit-dose system?
    1. Yes 2. No

68. What model of nursing practice is used?
    1. Team 2. Primary 3. Other, please specify _____

69. What is your nursing education? (Circle all that apply)
    1. LPN 2. Diploma 3. ADN 4. BSN 5. Masters degree in nursing

70. What other non-nursing degrees, if any, do you have?
    Please specify _____

71. What is your current position on your unit?
    1. Staff Nurse 2. Head Nurse/Other Administrative 3. Other, please specify _____

72. How often do you administer **non-IV** medications?
    1. Never 2. Rarely 3. Occasionally 4. Frequently

73. How often do you administer **IV** medications?
    1. Never 2. Rarely 3. Occasionally 4. Frequently

74. Are you employed full-time or part-time in your current position in this institution?
    1. Full-time 2. Part-time

75. What is the average number of times you float between units per month?
    0 1 2 3 4 5 6 7 8 9 10 11+

76. How many different units do you float between in a year?
    1 2 3 4 5+ Not applicable, I do not float between units

77. Type of nursing unit to which your responses apply (CHOOSE ONLY ONE RESPONSE):
    1. Medical 6. LTC/SNF 11. PICU
    2. Surgical 7. CCU 12. Psychiatry/Mental Health

3. Medical/Surgical
4. Obstetrics
5. Pediatrics
8. ICU
9. MICU
10. SICU
13. Float Pool Nurse
14. Other, please specify _____

Do you have any suggestions for improving the current system for monitoring medication errors?

Please return the completed survey to the location designated by your head nurse. Thank you again for your participation in this survey

Appendix C

From: Kristen Selig <kjselig2@comcast.net>
Sent: Wednesday, January 8, 2020 8:17 PM
To: Wakefield, Bonnie
Subject: Instrument

Hi Dr. Wakefield. My name is Kristen Selig and I am a PhD student at the University of Wisconsin Milwaukee. I am searching for the author of the Medication Administration Error Reporting Survey. If I am correct it is you. I am doing my research on Clinical instructor perceptions of the contributing factors of nursing student medication errors and am requesting permission to use the tool.

Kristen Selig
PhD Nursing Student

On January 9, 2020 at 8:59 AM "Wakefield, Bonnie" <wakefieldb@missouri.edu> wrote:

Hi Kristen, feel free to use!

****

Bonnie J Wakefield, PhD, RN, FAAN
Associate Professor
Sinclair School of Nursing
115 Business Loop 70W
University of Missouri
Columbia, MO 65211-6000
wakefieldb@missouri.edu
Phone: 573-882-5689

From: KRISTEN SELIG <kjselig2@comcast.net>
Sent: Thursday, January 9, 2020 11:26 AM
To: Wakefield, Bonnie
Subject: Re: Instrument

Dr. Wakefield. I greatly appreciate your permission. I forgot to ask if it is ok to modify the tool. I am surveying clinical instructors perceptions of their nursing students and would like to alter some of the questions to reflect nursing students and not nurses. I also do not need the section on reporting of medication errors.

Kristen Selig

---------- Original Message ----------
From: "Wakefield, Bonnie" <wakefieldb@missouri.edu>
To: KRISTEN SELIG <kjselig2@comcast.net>
Date: January 9, 2020 at 11:30 AM
Subject: Re: Instrument

yes, that's fine

****

Bonnie J Wakefield, PhD, RN, FAAN
Associate Professor
Sinclair School of Nursing
115 Business Loop 70W
University of Missouri
Columbia, MO 65211-6000
wakefieldb@missouri.edu
Phone: 573-882-5689

Appendix D

Medication Administration Error and Near Miss Survey

The following questions seek your input, based on your clinical/teaching experience, on the contributing factors of undergraduate student nurse medication errors and near misses. Check the box that best reflects the extent to which you agree/disagree that the following reasons contribute to why medication errors or near misses occur in undergraduate nursing students

	Strongly Disagree (1)	**Moderately Disagree (2)**	**Slightly Disagree (3)**	**Slightly Agree (4)**	**Moderately Agree (5)**	**Strongly Agree (6)**
15. The names of many medications are similar.						
16. Different medications look alike.						
17. The packaging of many medications is similar.						
18. Physicians' medication orders are not clear						
19. Pharmacy delivers incorrect doses to this unit.						
20. Pharmacy does not prepare the med correctly.						
21. Pharmacy does not label the med correctly.						
22. Students do not receive enough instruction on medications.						
23. There is no easy way to look up information on medications.						
24. Students have limited knowledge about medications.						
25. Students are interrupted while administering medications to perform other duties.						
26. All medications for one team of patients cannot be passed within an accepted time frame.						
27. Equipment malfunctions or is not set correctly (e.g., IV pump).						
28. Patients are off the unit for other care.						

Appendix E

Dear Professor _____,
I, Kristen Selig, a Ph.D. Candidate from the University of Wisconsin Milwaukee, would like to request your clinical instructor's participation in the online survey study, titled, Medication Administration Error Reporting Survey. I am asking that you forward the below email to undergraduate nursing clinical instructors in your program. The purpose of the study is to identify the contributing factors to undergraduate prelicensure student nurse medication administration errors and near misses in the clinical setting as perceived by clinical instructors. This may lead to the development of a better understanding of the factors that contribute to medication errors and near misses in undergraduate nursing students and lead to improvements in nursing curriculum and teaching medication safety. The online survey is completely anonymous and will take no more than 5-10 minutes of your clinical instructor's time.

Please forward the recruitment email below to undergraduate prelicensure clinical instructors. You may copy and paste the recruitment email to your email to the instructors. If you have further questions about the study, please do not hesitate to contact me using my contact information below.

Thank you very much for your cooperation.

Sincerely,

Kristen Selig MS, RN
Ph.D. Candidate
University of Wisconsin Milwaukee
College of Nursing
kmselig@uwm.edu
815-766-0844

Appendix F

Dear Clinical Instructor,

A Ph.D. Candidate from the University of Wisconsin Milwaukee, College of Nursing, would like to ask your participation in the online survey, titled, Medication Administration Error Reporting Survey. The purpose of the study is to identify the contributing factors to undergraduate prelicensure student nurse medication administration errors and near misses in the clinical setting as perceived by clinical instructors. This may lead to the development of a better understanding of the factors that contribute to the medication errors and near misses in undergraduate nursing students and lead to improvements in nursing curriculum and teaching medication safety. The online survey is completely anonymous and will take no more than 5-10 minutes of your time. Please feel free to contact me by email or by phone if you have any questions about the study at all: Kristen Selig at kmselig@uwm.edu or at (815) 766-0844. You may also contact the University of Wisconsin Milwaukee Institutional Review Board at 414-229-3173 / irbinfo@uwm.edu for further information regarding your rights as a participant.
Please click on the link provided below to continue to the survey.

https://niu.az1.qualtrics.com/jfe/form/SV_aVvhMTJs1eP0Dn7

Your participation is greatly appreciated. Thank you very much!

Sincerely,

Kristen Selig, MSN, RN
Ph.D. Candidate
College of Nursing
University of Wisconsin Milwaukee
kmselig@uwm.edu
(815) 766-0844

Appendix G

Informed Consent

I agree to participate in the online survey, entitled, Medication Administration Error Reporting Survey, by Kristen Selig, Ph.D. Candidate at the University of Wisconsin Milwaukee. The purpose of the study is to identify the contributing factors to undergraduate prelicensure student nurse medication administration errors and near misses in the clinical setting as perceived by clinical instructors.

I understand that participation in this study includes answering questions on a survey questionnaire online. I understand that responses will be completely anonymous. No personal identifying information will be collected, and the survey is set so as not to collect respondents' email/IP addresses. To ensure confidentiality, data will also be kept in secure, password-protected electronic repositories, accessible only to the researcher. I understand that this study was approved by the University of Wisconsin Milwaukee's Institutional Review Board, and the survey should last no more than 5-10 minutes.

I am aware that my participation is totally voluntary and may be withdrawn at any time. Since the study is completely anonymous and is purely fact-finding, I understand that it is unlikely that I will experience risks and/or discomforts during this study. I understand that my consent to participate in this project does not constitute a waiver of any legal rights or redress I might have as a result of my participation.

I understand that the intended benefit of the study is to develop a better understanding of the factors that contribute to the medication errors and near misses in undergraduate nursing students and lead to improvements in nursing curriculum and teaching medication safety.

Thank you very much!

For questions about the research
815-766-0844 / kmselig@uwm.edu
For questions about your rights as a research participant contact:
414-229-3173 / irbinfo@uwm.edu

☐ Yes I consent

☐ No I do not consent

Appendix H

UNIVERSITY of WISCONSIN
UWMILWAUKEE

Department of University Safety & Assurances

Melody Harries
IRB Administrator
Institutional Review Board
Engelmann 270
P. O. Box 413
Milwaukee, WI 53201-0413
(414) 229-3182 *phone*
(414) 229-6729 *fax*

uwm.edu/irb
harries@uwm.edu

New Study - Notice of IRB Exempt Status

Date: April 16, 2020

To: Kim Litwack
Dept: Nursing

CC: Kristen Selig

IRB #: 20.280
Title: The contributing factors to student nurse medication errors and near misses in the clinical setting as identified by clinical instructors

After review of your research protocol by the University of Wisconsin – Milwaukee Institutional Review Board, your protocol has been granted Exempt Status under Category 2 as governed by 45 CFR 46.104(d).

This protocol has been approved as exempt for three years and IRB approval will expire on April 15, 2023. Before the expiration date, you will receive an email explaining how to either keep the study open or close it. If the study is completed before the expiration date, you may notify the IRB by sending an email to irbinfo@uwm.edu with the study number and the status.

Any proposed changes to the protocol must be reviewed by the IRB before implementation, unless the change is specifically necessary to eliminate apparent immediate hazards to the subjects. You are responsible for adhering to the policies and guidelines set forth by the UWM IRB, maintaining proper documentation of study records and promptly reporting to the IRB any adverse events which require reporting. You are also responsible for ensuring that all study staff receive appropriate training in the ethical guidelines of conducting human subjects research.

You must also adhere to UWM and UW System Policies, and any applicable state and federal laws governing activities which are independent of IRB review/approval (e.g., FERPA, Radiation Safety, UWM Data Security, UW System policy on Prizes, Awards and Gifts, state gambling laws, etc.). When conducting research at institutions outside of UWM, be sure to obtain permission and/or approval as required by their policies.

Contact the IRB office if you have any further questions. Thank you for your cooperation, and best wishes for a successful project.

Respectfully,

Melody Harries
IRB Administrator

CURRICULUM VITAE

KRISTEN M SELIG

EDUCATION:

University of Wisconsin, Milwaukee **Doctor of Philosophy in Nursing**	2020
Northern Illinois University, DeKalb IL **Masters of Science, Nursing** Area of Concentration: Nursing Education	2012
Northern Illinois University, DeKalb, IL **Bachelors of Science, Nursing** Honors: Summa Cum Laude	2010
Waubonsee Community College **Associate Degree, Nursing**	1990

PROFESSIONAL LICENSURE/CREDENTIALING:

Registered Professional Nurse, IL License	1991-Present
Certified Healthcare Simulation Educator (CHSE)	2014-Present

ACADEMIC/TEACHING EXPERIENCES:

Northern Illinois University Nursing Laboratory and Human Patient Simulation Director	2012-Present
First Semester Coordinator	2013-Present
Instructor	2012-2016
Nursing Lab Coordinator	2008-2012
Waubonsee Community College Adjunct Clinical Faculty	2012-Present
Kaplan, Inc NCLEX-RN Faculty	2013-2014 2010-2011

National Council State Boards of Nursing (NCSBN)
Consulting: Scenario editing for the National Simulation Study
2007-2010

Northern Illinois University
Learning Lab Assistant

Professional work experience:

Kishwaukee Community Hospital 2008-2010
Staff Nurse

Community Coordinated Child Care 2006-2008
Nurse

Delnor Community Hospital 1990-2006
Staff Nurse/Patient Care Coordinator

PUBLICATIONS:

Oldenburg, N., Brandt, K., Maney, C., **Selig, K.** (2012). Student-created scenarios in the high fidelity simulation laboratory. *Journal of Nursing Education, (51)*, 12.

Rossetti, J., Musker, K., Smyth, S., Byrne, E., Maney, C., **Selig, K.**, Medina Poeliniz, C. & Andersen, S. (2013) *Creating and Evaluating "The Mental Health Ward": Undergraduate Nursing Students' Perspectives of a Simulated Patient Care Experience.* Presentation, Sigma Theta Tau International 42nd Biennial Convention, Indianapolis, IN.

Rossetti, J., Andersen, S., Medina Poelinz, C., **Selig, K.**, Maney, C., Byrne, E., Smyth, S., Musker, K., & Jones-Bendel, T. (2013) *Creating and Evaluating "The Mental Health Ward: An International Collaborative Evidence Based Simulation.* Presentation, American Psychiatric Nurses Association, 27th Annual Conference, San Antonio, TX.

PRESENTATIONS:

Poster

Abendroth, M., Selig, K., & Christiansen, K. (2016, June). Increased Risk for Strain Related to Greater Frequency of Occurrence of Physical Health Symptoms in Caregivers of Persons with Parkinson's disease. 36th Annual American Holistic Nurses Association Conference-Interconnectedness, the Soul of Holistic Nursing, Bonita Springs, FL.

HONORS AND AWARDS:

Northern Illinois University College of Health & Human Sciences 2018
Fisher Award for Excellence in Service

Nurses Education Funds, Inc. Mathy Mezey Scholarship 2017

Northern Illinois University-Supportive Professional Staff Certificate of Recognition	2014

PROFESSIONAL NURSING MEMBERSHIPS:

Midwest Nursing Research Society (MNRS), member	2015-2019
Sigma Theta Tau International Honor Society (STTI)	2010-Present
Beta Omega Chapter member	
American Nurses Association (ANA), member	2016-2019

PROFESSIONAL DEVELOPMENT AND ACTIVITIES:

IMSH	San Diego California	January 2020
2019 QSEN National Forum	Cleveland Ohio	May 2019
Host and presenter at Chicagoland Nursing Simulation Interest Group	NIU School of Nursing	July 2018
INACSL Conference 2018	Ontario Canada	June 2018
Undergraduate Curriculum & Evaluation Committee	NIU School of Nursing	2014-Present
Chair, Simulation Subcommittee	NIU School of Nursing	2012-Present
Clinical Simulation Facilitator Workshop	Central DuPage Hospital Northwestern Medicine	2017
MNRS Annual Research Conference	Minneapolis Minnesota	2017
MNRS Annual Research Conference	Milwaukee Wisconsin	2016
Chicagoland Nursing Simulation Interest Group (CNSIG)	Started by NIU, ECC, and Chamberlain	2013-Present
International Nursing Simulation/Learning Resource Center Conference	International Nursing Association for Clinical Simulation and Learning (INACSL)	2011

Human Patient Simulation Network (HPSN) 2011	Medical Education Technologies, Inc. (METI)	2011
Creating High Fidelity Characters and Environments	Oregon Health and Science University	2010
HPSN 2010-Simulation Conference	METI	2010
Teaching Clinical Judgment through Simulation	Oregon Health and Science University	2009

Faculty Advisor Student Nurse Organization	2015-2017
Student Nurse Political Action Day	2012-Present
Illinois Medical Emergency Response Team (IMERT), member	2005-2015
Student Representative Graduate Council at Northern Illinois University	2011-2012
Student Representative University Fellowship Committee	2011-2012
Student Representative University Student Advisory Council	2011-2012
Alternate on the Provost Strategic Planning Workgroup	2011-2012
U.S. President's award for volunteer hours	2007