Nurses' Perceived Skills and Attitudes About Updated Safety Concepts: Associations with Medication Administration Errors and Practices

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This work is dedicated to the memory of my father, Deshler D. Armstrong, who embodied the spirit of inquiry. He both role-modeled and encouraged the pursuit of education to expand one's mind and one's opportunities in life.

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LIST OF ABBREVIATIONS

ADE – Adverse Drug Event

BCMA – Bar Code Medication Administration

CALNOC – Collaborative Alliance for Nursing Outcomes

COMIRB – Colorado Multiple Institution Internal Review Board

CNO – Chief Nursing Officer

CPOE – Computer Physician Order Entry

EHR – Electronic Health Record

HPPSACS – Healthcare Professionals Patient Safety Assessment Curriculum Survey

IOM – Institute of Medicine

MAE – Medication Administration Errors

MAR – Medication Administration Record

MROPF – Minnick Roberts Outcome Production Framework

NASUS – Nurses' Attitudes and Skills Around Updated Safety Concepts Scale

PDSA – Plan Do Study Actp

PS-ASK – Patient Safety, Attitudes, Skills and Knowledge Survey

QI – Quality Improvement

QSEN – Quality and Safety Education for Nurses

CHAPTER I

INTRODUCTION AND BACKGROUND

Overview

This doctoral research explores the impact of nurses' perceived skills and attitudes about updated safety concepts and the impact on medication administration errors and practices. Medication administration errors continue to be a recurring, concerning safety lapse in hospital care, and research has been done to examine systems variables and nurses' practices that contribute to errors. However, a review of the literature produced no studies on nurses' skills with and attitudes about updated safety concepts, which in turn guide practice, as well as unit-level and system-level improvements.

Significance

In the last decade patient safety has become a more urgent concern because of increasingly available data that harm is a prevalent phenomenon in US hospitals. The publication of *To Err Is Human* by The Institute of Medicine (IOM) in 2000 was a landmark report on the occurrence of preventable error in US hospitals[1]. Recent data suggest almost no improvement in making hospitals safer since that time.[2] Improved reporting systems indicate that the true number of premature deaths associated with preventable harm in hospitals to patients is closer to 400,000/year.[3] This recent statistic would make medical error the third leading cause of death in the US.[3] Current patient safety research conducted in the acute care setting suggests that there is a 13% level of harm in hospitals.[4] Thus, as many of as 25% of all hospitalized patients will experience a preventable medical error of some kind, and as many as 100,000 will die annually from these preventable errors.[4] When considering the plethora of patient safety data in the literature in the last 16 years, the consistent message is that the US healthcare system has yet to significantly improve patient safety outcomes.

The financial cost of lapses in patient safety can be extreme. IOM data suggest that compromises to patient safety in US hospitals costs between $17 billion and $29 billion per year.[1,5] A review of data of more than 950,000 patient safety incidents analyzed related care as costing $8.9 billion.[5]

The most frequently occurring work performed by nurses in hospitals is administering medications, and this work can account for as much as 40% of nurses' time.[6,7] Thus it is easy to understand how medication errors are the most common errors in the hospital setting and contribute to one-third of all hospital adverse events.[8,9]

Research is ongoing to accurately quantify medication administration error (MAE) occurrences in the hospital. Although medication errors can occur in the prescribing, transcribing, dispensing, administering, adherence or monitoring stages, research indicates that one-quarter to one-third of medication errors occur at the administration stage and always involve the frontline nursing clinician.[10] A review of the literature indicates inconsistent operational definitions and varied approaches to measurement in accurately quantifying the occurrence of MAEs.[11] Two common approaches to reporting MAE rates are to calculate MAEs based on overall doses on a unit or to calculate errors per patient. It is most helpful to calculate all medication doses for a unit or facility and then identify the subset of MAEs. The value of placing MAE rates in the context of all doses is clear identification of the clinical significance of the error percentage. For example, a busy nursing unit, with a high volume of medications administered will naturally have a higher number of errors than a less busy unit. This methodology was used in early MAE research. Early nursing research on MAEs reported an error rate of 60%, indicating that more than half of all medications administered included some type of administration error.[12] The most common standardized way to report MAEs is as errors/100 doses. This methodology allows meaningful comparison of MAEs across different size nursing units. Based on the measurement technique, studies indicate that MAE occurrence ranges between 2.4-11.1/100 doses;[13] up to 19% of medications administered in the hospital setting include an administration error; [14,15] or MAEs average one MAE per patient per day.[13,16] No matter how one reports MAEs, the costs are significant; a 2015 study found that there were an average of $7,000 additional charges to the payer for treatment costs associated with MAEs.[17] The wide range of reported occurrences illuminates the current need for well-designed MAE research studies that standardize definitions and methods. Despite their frequency, patient

safety lapses involving medication administration are a significantly expensive and poorly understood area of error in healthcare.

Related Work

Types of Reported and Observed Medication Administration Errors

Quantification of the number and type of medication administration errors is a common area of research. Recently the concept of adherence to safe medication practices, using observational methodology, has been a preferred approach to quantify this phenomenon.[14,18,19] The assumption is that adherence to a bundle of behavior practices specific to administration of medication will result in error-free events. These behaviors include: compares medication with Medication Administration Record (MAR), medication labeled throughout the process from preparation to administration, checks two forms of identification, explains medication to the patient, and charts medication immediately after the administration.[18] The most commonly occurring variation to safe practice occurs in a) checking two forms of patient identification and b) not charting the medication immediately after administration. In reviews of medication administration research which focused on the Five Rights (right medication, right dose, right patient, right route and right time), "wrong time" topped the list for the most common medication error accounting for up to 43% of MAEs.[20] The second most commonly reported medication error was "wrong dose", accounting for up to 41% of MAEs.[21] However, little is known about the severity of error or clinical impact of errors on patient outcomes; one study examined severity of MAEs and found that only 1% of medication administration errors was categorized as "severe."[22]

Factors Associated with MAEs

Staffing: There are conflicting results on the effect of staffing on MAE, likely because diverse aspects of staffing were examined. Studies of RN skill mix on MAE rates have suggested that higher RN skill mix resulted in lower MAE rates[23–26] while others found no correlation.[27] Studies that examined nurse experience suggested that inexperienced staff were involved only in 14.9% - 17% of medication errors, thus indicating that the bulk of errors occur among experienced staff --- a counterintuitive

finding.[28,29] One study examined the effect of long shifts (>12 hours) on a nurse's MAE rates and concluded that the risk of medication administration error can be nearly three times higher once a nurse worked more than 12.5 hours during a 24 hour period.[30]

Nurse-Focused Interventions to Reduce MAEs

Educational Interventions: The most common intervention employed to decrease medication errors was an educational intervention. Foci of educational interventions included pharmacovigilant activities,[31] medication safety,[32–35] the evidence supporting real time charting,[36] how to use a computerized medication administration program,[37]medication error reduction,[38,39] quality improvement (QI) [40] and Plan-Do-Study-Act (PDSA) processes,[41] medication administration errors to avoid,[42] insulin pharmacokinetics,[43] medication administration procedures, and medication calculation.[44] It is noteworthy that a majority of the studies focusing on an educational intervention reported a reduction in MAE rates. In the studies that tracked MAE rates, these reductions ranged from a 2% reduction[34] to a 100% reduction.[41] However, beyond a one to three month follow-up, none of the educational interventional studies described plans to study sustainability of the reduced MAE rates. Also striking was the traditional nature of the content areas taught. With the exception of one study that taught nurses about QI processes,[40] none of the studies employed updated concepts of safety (e.g. complex adaptive systems, safety science) in educating nurses.

System-Level Interventions to Reduce MAEs

Bar Code Medication Administration: A common systems-level intervention to reduce MAEs is Bar Code Medication Administration (BCMA). In a review of BCMS studies, most indicated an initial increase in MAEs followed by an eventual decrease.[45] Many studies examined various aspects of BCMA, so the mechanism of reduction was not clear when looking across studies. MAE rates of reduction ranged from a 4.2% [46] reduction to 79% [47]reduction. BCMA systems were often studied with other concurrent interventions (e.g. CPOE and electronic health record [EHR] systems), which obfuscated the contribution that BCMAs made in the reported MAE reduction. BCMA interventions were one of the more common interventions where nurse workarounds were noted. Nurse workarounds actually

contributed to higher MAE rates and were usually related to system unpredictability (e.g. unreadable barcodes, malfunctioning scanners, failing batteries, unreadable or missing patient information).[48] Hung et al found that technology is positively related to medication errors, indicating that nursing units with highly complex technology had higher medication error rates.[49] Similarly, a BCMA study[50] studied the increase steps (from five to eight) and increased time (from 0.8 minutes to 1.5minutes) of a BCMA system and concluded that nurses and pharmacy staff should be continually educated on the benefits of this technology that outweigh the disadvantages. An understanding of how nurses perceive technological improvements is important in appreciating how they decide to adopt or work around new interventions. Using the context of updated safety concepts (e.g. decreasing variability and increasing standardization) would be a helpful framework for educating clinicians.

Computer Physician Order Entry Systems (CPOE): Computer Physician Order Entry systems are another common intervention to study in association with MAEs. One study indicated an interrupted nurse workflow when systems are designed without an understanding of how nurses work.[51] Other studies incorporated CPOE as one of several simultaneous interventions (e.g. BCMA and automated dispensing system), and indicated a 4.4% reduction in MAEs and an increase of intercepting 73 errors per 100,000 doses.[34,52]

Physical and Work Environment: One approach to understanding the impact of environment on MAEs is to examine the effect of physical alterations to a nursing unit (e.g. wall cupboards and physical barriers) on medication error rates.[53,54] In adjusting physical elements of the nursing environment, the important impact of corollary phenomena (e.g. disruptions and interruptions) becomes clear.

Research about facets of work environment that contribute to MAEs has recently focused on quantifying and suspending disruptions and distractions. One 2013 study identified workload, distraction and ineffective communication as the significant contributors to MAEs across several hospital settings.[55] The common environmental intervention of creating "distraction free" zones for nurses has had varied outcomes. In one 2015 study, an approach borrowed from aviation, called the "sterile cockpit" principle was applied to reduce distractions and interruptions. Nurses were educated about the evidence of

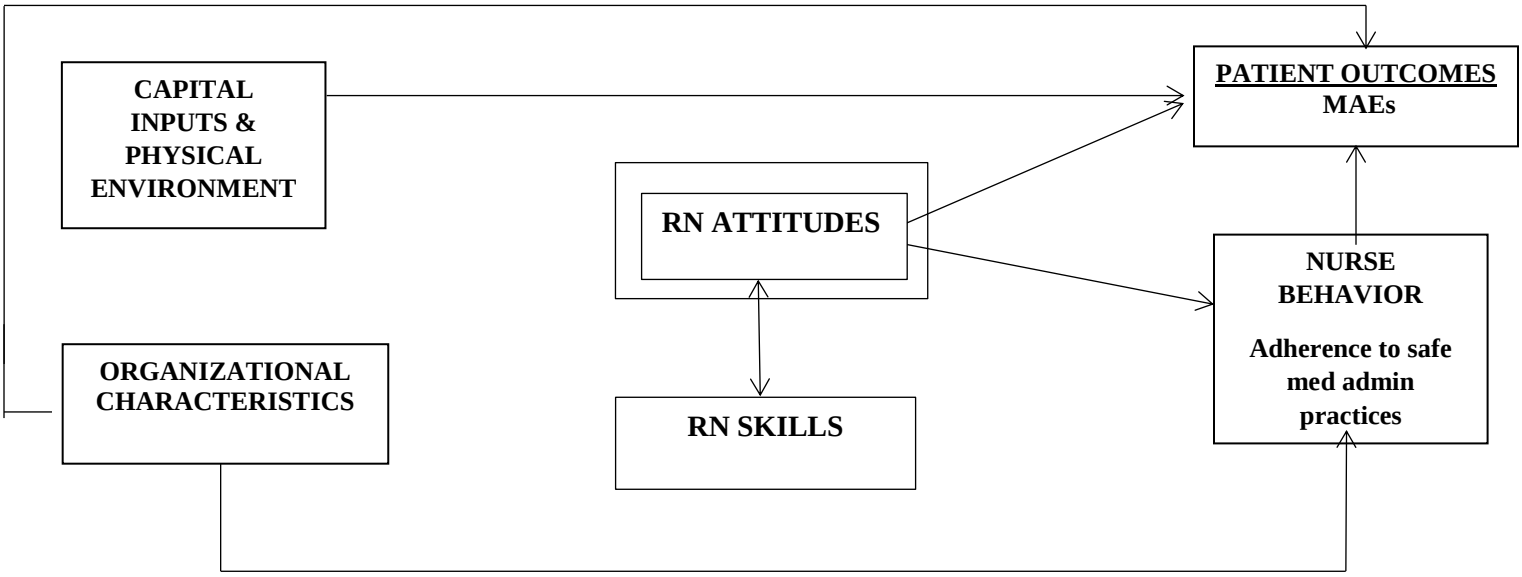
interruptions on medication preparation, a standardized quiet location was provided for preparing medications, nurses were provided a checklist for preparation/administration, and nurses were given a vest to wear while preparing or administering medications. In this study, 30%-50% of nurses did not follow the protocol, reporting barriers of forgetfulness, negative feedback, and personal beliefs. Additionally, errors increased from 1.74/1000 patient days to 2.88/1000 patient days.[56] A similar study asked nurses to track and intercept distractions while colleague nurses (wearing medication prep vests) were preparing or administering medications. The number of tracked distractions decreased and the MAE rate decreased by 42%.[57]A review of studies that examine disruptions to nurses during medication administration concludes that a significant gap exists in identifying sustainable strategies that assist nurses in safely managing interruptions in the clinical environment.[58]

In summary, despite the plethora of studies examining MAEs, a number of gaps remain on a) the degree and severity of MAEs on medical/surgical units, b) nurses' knowledge of MAEs or attitudes towards MAEs in their practice, and c) the relationship of MAE with mutable organizational factors and nurses' knowledge and attitudes. This study addressed these gaps. The following chapter addresses the study methodology.

Conceptual Framework

Given the institutional, unit and individual variables that may impact MAE rates, this study used a theoretical framework adapted from the Minnick and Roberts Outcome Production Framework (MROPF)[59] and the Shimokura model of skepticism[60] (Figure 1.1).

Figure 1.1: Theoretical Framework: Adaptation of two frameworks: the Minnick & Roberts Model (1991) and Shimokura Model (2006)



The MROPF organizes capital, labor and institutional process variables to examine the interaction of these multi-level variables. It also examines those relationships with the outcomes. A strength of this framework is that it emphasizes factors amenable to administrative interventions. Second, the presentation of interacting variables from various levels of operations allows real-world complexity to be reflected in this model. A limitation of the MROPF is the lack of definition or guidance regarding RN attitudes. Thus, the concept of skepticism is adapted from Shimokura et al's model,[60] which identifies 7 aspects of practice that influence poor adherence to recommended evidence-based practices. The model used by the described study suggests that MAEs and nurses' adherence to safe medication administration practices result from interactive processes among capital inputs, organizational characteristics, and RN skills and attitudes.

Capital Inputs: The concept of *capital inputs* include facets of the hospital practice environment that reflect significant financial investment by healthcare agencies. Examples include use of BCMA, CPOE, or alteration of the physical environment to facilitate medication administration (e.g. separate medication preparation area to avoid distractions, physical alteration of the environment).

Organizational Characteristics: *Organizational characteristics* address features of an organization that affect worker autonomy (e.g. identification of a culture of safety, Magnet status, size of agency, or rural/urban location). Organizational variables influence work environment and practice standards at the unit level.

Nurse Characteristics *RN skills* are specific to updated safety concepts and focus on the nurse's comfort with skills such as reporting adverse events, analyzing a case to find the cause of an error, reporting an error to a manager, and interpreting aggregate report data. *RN attitudes* reflect the individual temperament of the nurse clinician that can impact adoption of practice improvements based on updated safety concepts. These aspects of the nurse clinician include the degree to which the nurse's professional values reflect updated safety concepts, and degree of skepticism.

Skepticism reflects the degree to which nurses believe in the efficacy of the evidence-based practice.[60] This particular concept has not been examined in any of the MAE literature. Skepticism is relevant to MAEs because the concept highlights not only an individual clinician's knowledge of evidence-based practice, but also any accompanying doubt of the guideline's effectiveness that may affect a clinician's adherence to evidence-based practice. Administration of medications is a complex phenomenon where clinicians respond to a variety of concurrent influences. Gauging skepticism about the value of proven evidence-based practices will be important in obtaining a complete picture of influences on MAE.

Specific Aims

Based on identified gaps in the literature related to variables that impact MAEs, the primary goal of this pilot study was to further explore the relationship among individual, unit and organizational mediated variables related to updated safety concepts and MAEs.

Specific Aims were to:

1. Develop and test the psychometrics of a scale assessing nurses' perceived skills and attitudes about updated safety concepts.

2. Examine associations between perceived skills and attitudes and their impact on unit-level MAE rates and unit-level adherence to safe medication administration practices.

CHAPTER II

THE DEVELOPMENT AND PSYCHOMETRIC ANALYSIS OF A NURSES' ATTITUDES AND SKILLS SAFETY SCALE: INITIAL RESULTS

This chapter reports the results of aim one, which were achieved through a pilot study that developed and tested a new scale to assess nurses' skills and attitudes about updated safety concepts. The results of this pilot study contributed to recommendations for adjusting the scale for future research.

Background

In the last decade patient safety in healthcare has become an urgent concern for the public and healthcare industry leaders, given its prevalence in US hospitals. Indeed, unintentional harm from medical errors is the fourth leading cause of death in the U.S.[61] The financial cost of patient safety can be excessive with estimates ranging from $17 to $29 billion per year.[62]

Since the advent of quality and safety research, safety principles have been updated with increased emphasis on system contributions to safety lapses rather than focusing primarily on individuals' contributions or fault. [1] Much work has been done at the administrative level to incorporate these updated safety principles in the analysis of errors and updating of norms, policies and standards.[63] Thus, it is now common for administrative personnel to focus their attention on the system level variables that contribute to error and lapses in patient safety.[64] However, despite the system efforts that have been made to address patient safety, patient injury and death from healthcare system or providers' care remains widespread.[4] The heightened emphasis placed on system level analysis may have obscured the individual provider's contribution to patient safety practices. Specifically, little is known regarding bedside RNs' attitudes towards updated safety concepts that guide organizational policy and standards. Moreover, little is known about nurses' perceptions of their skills in implementing safety principles, such as initiating, executing and revising standardized processes of care to better manage patients within complex work environments. Most models of nursing practice include individual clinician attitudes and skills as vital variables in the establishment of practice norms; safety practices are no exception.[60] Given that nurses are typically at the

sharp end of a number of health care errors, most notably medication administration, understanding their attitudes and perceived skills could assist organizations in identifying targeted strategies to enhance nurses' safety practices. However, a search of the literature yielded no standardized instruments to assess nurses' attitudes and perceived skills. Therefore, the aims of this study were to a) develop a scale assessing nurses' perceived skills and attitudes toward updated safety concepts based on a literature review, b) determine content validity of the scale's items, and c) examine the psychometric reliability of the scale and subscales.

Methods

Aim 1: Item Development

Phase I: Review of Definitions and Conceptual Frameworks

A literature review was conducted to identify patient safety definitions and concepts. Various healthcare organizations and researchers have addressed nuances of patient safety, providing a number of conceptual frameworks and definitions (see Table 2.1).

Table 2.1. Definitions of Patient Safety

Organization/Year	Patient Safety Definition	Source
Institute of Medicine (1999)	Freedom from accidental injury	*To Err Is Human*
Agency for Healthcare Research and Quality	Freedom from accidental injury or preventable injury produced by medical care	AHRQ PSNet – Patient Safety Network: https://psnet.ahrq.gov/glossery
Quality and Safety Education for Nurses (QSEN) 2007	Minimizes risk of harm to patients and providers through both system effectiveness and individual performance	www.qsen.org
National Patient Safety Foundation (no date)	Prevention of healthcare errors and the elimination of mitigation of patient injury caused by healthcare errors.	www.npsf.org
Emanuel, Berwick, Conway, Combes, Hatlie, Leape, Schyve, Vincent & Walton (2005)	Patient safety is a discipline in the healthcare sector that applies safety science methods towards a goal of achieving a trustworthy system of health care delivery. Patient safety is also an attribute of healthcare systems; it minimizes the incidence and impact of, and maximizes recovery from adverse events.	Advances in Patient Safety: New Directions and Alternative Approaches (Volume 1): AHRQ

The initial definition of patient safety from the Institute of Medicine's (IOM) *To Err Is Human*, is "freedom from accidental injury." [1] This definition has been further expanded to include freedom from injury produced from medical care; [65] minimize risk of injury to patient and provider through system and individual performance, [66] and prevention of healthcare errors.[67] Emanuel et al's definition [68] further expands the patient safety concept by including elements from the emerging field of Safety Science. Their definition acknowledges that patient safety can be understood at the individual clinician level as well as at the systems level. The impact of human factors engineering is evident in this more expansive definition of patient safety.

In 2007 Cronenwett et al, in their national Quality and Safety Education for Nurses (QSEN) research and initiative, [66] conducted a conceptual deconstruction of the knowledge, skills and attitudes

(KSAs) needed by healthcare professionals to address patient safety. Working with an advisory board of thought leaders in nursing and medicine, the authors reviewed the relevant literature and adapted the IOM competencies for nursing as well as proposed targets for competence. Descriptions and operationalized facets of KSAs that would apply to all registered nurses resulted.[66] Although QSEN KSAs have been studied in pre-licensure nursing students,[69] there is a dearth of research examining the presence of these KSAs among bedside nurse clinicians.

Phase II: Development of Knowledge, Skill and Attitude Items

The literature was reviewed for instruments specific to domains of patient safety. [70] Nine scales were found that assessed the safety competencies of nurses, however seven of these were developed for pre-licensure nursing students, with minimal application to practicing nurses. Modification of the two remaining scales (Schnall's Patient-Safety Attitudes, Skills and Knowledge Survey[71] and Chenot & Daniel's Health Professions Patient Safety Assessment Curriculum Survey[72] contributed to the scale development targeted to bedside nurses.

Schnall's PS-ASK Survey is an adaptation of a survey for medical residents initially developed by Madigosky, and colleagues [73] to measure medical students' knowledge, skills and attitudes about patient safety and medical fallibility. Based on James Reasons' model of human error, [74] Schnall adapted Madigosky's et al's survey to reflect patient-safety curriculum objectives and evidence-based, patient-safety practices relevant to advanced practice nurses, which resulted in the 50 item PS-ASK.

Chenot & Daniel (2010) developed the Healthcare Professionals Patient Safety Assessment Curriculum Survey (HPPSACS), also based on Madigosky's survey for medical residents. Chenot's HPPSACS Survey is a 34 item survey, adapted for nurses, was reviewed by nurse content experts in its development and is now widely used with pre-licensure nursing students.

The *Nurses' Attitudes and* Skills *around* U*pdated Safety Concepts (NASUS*) Scale

The first version of the NASUS Survey was a 34 item survey that adapted items from the PS-ASK and the HPPSACS, based on each instrument's coverage of the QSEN dimensions of patient safety outlined in the KSAs (see Table 2.2). Also considered were these instruments' reliability values associated with individual items and subscales. The NASUS Scale was developed using three attitude sections of the HPPSACS Survey (Cronbach Alpha =.86, .62 and .63), the Error Analysis skill subscale of the PS-ASK Survey (Cronbach Alpha = .84), and the Knowledge subscale of the PS-ASK Survey (Cronbach Alpha = .86), with minor edits. Each item of the NASUS employed a 100-point continuous visual analogue, with some questions employing reverse anchors, so these questions were reverse coded in analysis.

Table 2.2: Knowledge, Skill and Attitude Elements of Quality and Safety Education for Nurses (QSEN)'s Safety Competency Targets.

Proposed QSEN Target	**K, S, A**	**Item # in Nurses Scale**
Examine human factors and other basic safety design principles as well as commonly used unsafe practices (such as, work-arounds and dangerous abbreviations)	Knowledge	33
Describe the benefits and limitations of selected safety-enhancing technologies (such as, barcodes, Computer Provider Order Entry, medication pumps, and automatic alerts/alarms)	Knowledge	34
Discuss effective strategies to reduce reliance on memory	Knowledge	35
Delineate general categories of errors and hazards in care	Knowledge	31
Describe processes used in understanding causes of error and allocation of responsibility and accountability (such as, root cause analysis and	Knowledge	24

failure mode effects analysis)		
Discuss potential and actual impact of national patient safety resources, initiatives and regulations	Knowledge	32
Demonstrate effective use of technology and standardized practices that support safety and quality	Skill	27
Demonstrate effective use of strategies to reduce risk of harm to self or others	Skill	29
Use appropriate strategies to reduce reliance on memory (such as. forcing functions, checklists)	Skill	35
Communicate observations or concerns related to hazards and errors to patients, families and the health care team	Skill	27
Use organizational error reporting systems for near miss and error reporting	Skill	25
Participate appropriately in analyzing errors and designing system improvements	Skill	24
Engage in root cause analysis rather than blaming when errors or near misses occur	Skill	26
Use national patient safety resources for own professional development and to focus attention on safety in care settings	Skill	29
Value the contributions of standardization/reliability to safety	Attitude	9, 19, 37, 37
Appreciate the cognitive and physical limits of human performance	Attitude	3, 6, 7, 17
Value own role in preventing errors	Attitude	1, 10, 14, 23
Value vigilance and monitoring (even of own performance of care activities) by patients, families, and other members of the health care team	Attitude	2, 4, 5, 11, 12, 13, 15, 21, 22
Value relationship between national safety campaigns and implementation in local practices and practice settings	Attitude	18, 20

Effective and sustained adoption of evidence-based practices is also partially due to clinicians' skepticism about the value of a change in practice. Clinicians who are highly skeptical of the value of an evidence-base for care are less likely to adhere to these standards in their practice. [60] The concept of skepticism is included in the NASUS, specific to safe medication administration practices. The resulting first draft of the NASUS Survey had 8 Skill items, 21 Attitude items and 5 Knowledge items.

Aim 2: Establishing Content Validity

Content validity refers to the extent to which an instrument measures what it is expected to measure. In order to conduct an effective content validity index (CVI), 3-10 experts rate each scale item in terms of its relevance to the underlying construct. For the NASUS scale, nine experts (2 MDs and 7 RNs) completed a CVI. Standardized definitions were provided to clarify Safety, Knowledge, Skills and Attitudes. A 4 point scale with anchors of 'not relevant', 'somewhat relevant', 'quite relevant' and 'highly relevant' was used for each of the 32 NASUS items.[75] For each item, the CVI was computed as the number of experts providing a rating of 3 or 4, divided by the total number of experts. This approach effectively dichotimizes the scale into "relevant" and "not relevant" items.[76] When there are six or more expert reviews of a scale, the recommended criteria is that no item should be lower than a .78.[77]

Five items were eliminated because of low CVI scores. Additionally, several experts indicated that self-assessment of knowledge is an unreliable and biased assessment for most, and especially for healthcare professionals.[78] Several experts also questioned whether the knowledge items that were piloted in the NASUS were the best core elements in the knowledge domain to represent updated safety concepts. Therefore, the five questions that targeted nurses' assessment of their knowledge of updated safety concepts were eliminated. The net result of this content validity review process was a 24 item NASUS Survey (see Table 2.3).

Table 2.3: Nurses' Attitudes and Skills around Updated Safety Concepts (NASUS) Scale: Scale, Subscale, Item Descriptive Statistics, Inter-Item Correlation Ranges, Reliability Statistics

Item	Question	Median (IQR)	Item-Total Correlation	Cronbach's Alpha if deleted
Skill Subscale		**62 (52, 73)**	**Cronbach's ∞= .73**	
Skill Subscale: Choose the number that corresponds to your level of comfort with the following:				
1	Accurately completing an incident report	83 (65, 96)	.43	.68
2	Analyzing a case to find the cause of an error	75 (53, 90)	.63	.67
3	Supporting and advising a peer who must decide how to respond to an error	78 (65, 90)	.59	.66
4	Disclosing an error to a manager or supervisor	32 (10, 65)	-.23	.72
5	Disclosing an error to another healthcare professional	75 (51, 90)	.38	.68
23	Interpreting aggregate error report data	50 (26, 66)	.54	.69
24	Participating as a team in a root cause analysis	57 (38, 77)	.60	.68
Attitude Subscale		**68 (62,74)**	**Cronbach's ∞= .66**	
Attitude Subscale: Choose the number that corresponds to your level of agreement with the following statements:				
6	Making errors in healthcare is inevitable	63 (38, 80)	.14	.70
7	Competent healthcare professionals do not make errors that lead to patient harm	69 (50, 85)	.19	.69
8	Healthcare professionals should routinely spend part of their professional time working to improve patient care	86 (68, 100)	.49	.67
9	The culture of healthcare makes it easy for healthcare professionals to deal constructively with errors	42 (27, 66)	.07	.70
10	Healthcare professionals routinely share information about medical errors and what caused them	86 (72, 100)	.53	.67
11	Healthcare professionals routinely report errors	50 (32, 78)	.13	.69
12	Reporting systems do little to reduce future errors	67 (49, 85)	.18	.69
13	Physicians should be the healthcare professionals that report errors to an affected patient and family	50 (21, 65)	-.15	.72
14	After an error occurs, an effective	38 (19, 61)	.11	.72

	strategy is to work harder to be more careful			
15	There is a gap between what we know as "best care" and what we provide on a day-to-day basis	63 (33, 77)	.01	.72
16	Learning how to improve patient safety is an appropriate use of time in my practice	89 (73, 100)	.51	.68
17	If there is no harm to a patient, there is no need to address an error	94 (78, 100)	.49	.67
18	If I saw a colleague make an error, I would keep it to myself	85 (70, 99)	.43	.67
19	Most errors are due to things that healthcare professionals can't do anything about	85 (69, 96)	.39	.68
20	I have effective strategies in my practice to reduce my reliance on memory	74 (61, 86)	.32	.68
21	Standardized medication administration practices improve patient safety outcomes	86 (71,98)	.47	.68
22	Standardized medication administration practices get in the way of my nursing practice	80 (62, 95)	.35	.69
Total NASUS Scale		**66(60, 72)**	**Cronbach's ∞ = .73**	

Aim 3: Determining Pyschometric Reliability of the NASUS

To determine psychometric reliability properties of the NASUS, we conducted a cross-sectional study using a convenience sample of employed registered nurses (RNs) from hospitals participating in the Collaborative Alliance for Nursing Outcomes (CALNOC) registry. CALNOC is a not-for-profit, self-sustaining, national registry that oversees nursing-sensitive measures collected at unit level of a hospital. CALNOC was launched in 1996 and began as one of six American Nursing Association pilot sites. By the end of 2014, CALNOC had aggregated close to 17 years of data, representing more than 2,000 patient units and over 94 million patient days (www.calnoc.org). CALNOC supports hospital collection of facility-specific and group benchmark data on nursing sensitive outcomes. As part of a larger study, this study targeted RNs employed on CALNOC hospital units that had collected medication administration data between November 2014 and April 2015.

Human Subjects Review Committees at University of California San Francisco and Cedars-Sinai Medical Center, the Vanderbilt Institutional Review Board Committee and the Colorado Multiple Institute Review Board Committee (COMIRB) approved the study. The introductory letter was explicit in stating that nurse participation was voluntary and anonymous, that there was no direct benefit of participation beyond contributing to nursing knowledge, and that the nurses would not be compensated.

Inclusion Criteria

All RNs who were currently practicing on targeted units were invited to participate in the study. There were no exclusion criteria.

Recruitment and Data Collection Procedures

Chief Nursing Officers (CNOs) at thirty- four facilities received the first inquiry, via emails and letters mailed through the US Postal System. Initial letters of invitation described the study and requested permission to contact the CALNOC Site Coordinator. Three waves of invitations were sent to CNOs (with a total of 6 communications) over four months, with a 30% response rate (n = 11). Of the eleven CNOs that responded to the invitation to participate, 64% (n = 7) agreed to participate. The principal investigator (PI) (GA) then contacted CALNOC Site Coordinators to describe the study and set up a phone meeting to answer subsequent questions and identify appropriate units. To maintain anonymity, the PI instructed the CALNOC site coordinators to email a letter of invitation to RNs employed on the identified units. From 7 agencies, 293 RNs responded to the NASUS Survey.

Data were collected and managed through REDCap (Research Electronic Data Capture), a secured web-based application designed to support data capture for research. The NASUS Scale in REDCap was developed employing web-based strategies for ease of reading and ease of completion.[79]

Data Management and Analysis

IBM SPSS Version 23 was used for all analyses. Collected data were examined for missing values, of which there was a minimum (.01%). No survey items were omitted from the analyses. Missing

data were examined for patterns of recurrence or systematic problems. There was no pattern of missing data clustering around an agency or unit. To minimize bias, any participant with three or missing items was removed from the database. [80] This criterion resulted in eight participants being removed from the database, for a total of 285 participants.

Graphical and descriptive statistical methods were used to evaluate data distributions. Continuous data distributions were skewed, therefore, median and interquartile range were used to summarize those data. No data transformations were necessary to meet statistical assumptions.

Psychometric reliability was examined using item-total correlation and Cronbach's alpha coefficient. Item-total correlation indicates the consistency of an item with the total of scores on all other items in the subscale. A low item-total correlation means the item is not well correlated with the overall scale. A target item-total correlation of .3 or higher indicates satisfactory consistency of the item responses with the remaining item responses. [81] Furthermore, if the internal consistency of the entire scale increased if a specific item was removed, that item was evaluated for possible wording issues or simply lack of consistency with the other items in the scale. Using this criterion, no items were removed from the scale (see Table 2.2). For the NASUS scale, a minimal Cronbach's alpha coefficient was established at .70 for this initial testing.[82–84]

Results

Table 3 displays the item median and interquartile ranges as well as item-total correlation values for each item. Item median values range from 32 to 89, suggesting good variability among the data. The three lowest median values (32, 38 and 42) were all associated with items that had a reverse visual analogue scale (items #4, 9 & 14), perhaps suggesting that participants responded the same way to all of the survey questions, without reading the items carefully.

The 24 item NASUS Survey had a Cronbach's apha of .73 indicating an acceptable level of consistency among items for a new survey. The Skill Subscale had a Cronbach's alpha of .71. The item-

total correlation for #4 was a -.23; this item focuses on the nurse's comfort with disclosing an error to a manager or supervisor.

The Attitude Subscale had a Cronbach's alpha coefficient of .67, indicating moderate internal consistency among this subscale's items. No items were deleted because this would not have improved the level of reliability of this subscale. In analysis of the item-total correlations, 8 questions did not meet the .3 target (#s 6, 7, 9, 11, 12, 13, 14, 15). Questions 6, 7, 9 and 15 focus on the occurrence of errors in healthcare, the stress of the healthcare environment, and the gap between awareness of errors and best practice. Questions 11, 12 and 14 focus on reporting practices and their value. Question #13 specifically addresses the healthcare professional who should address error phenomena with patients and families.

Discussion

As a first step in determining methods for intervention to enhance nurses' safety practices, we developed and tested psychometric properties of a scale that would elicit nurses' attitudes and perceived skills in performing safety principles. We found that overall, the NASUS Scale had an acceptable internal consistency.

During the last decade, tremendous improvements have occurred in how quality and safety are taught in pre-licensure education through the QSEN Initiative.[69] However the majority of the current nursing workforce were not educated in these updated concepts of safety. There is no existing instrument that attempts to assess this gap in education and skills. The NASUS Scale is the first instrument to address this disparity.

Nurses are the segment of the healthcare workforce that most frequently are responsible for and implement quality and safety measures to improve systems and patient outcomes. Some authors refer to the time, energy and emotional stress related to this "quality burden" as a phenomenon unique to nurses, which may impact nurses' attitudes about these elements of their practice. [85] Understanding nurses' attitudes about implementation of quality and safety initiatives is important in effective strategizing to

recruit their support. The NASUS Scale is the first survey to address this phenomenon, with this pivotal clinical population.

Most competency-based models examine the necessary knowledge, skills and attitudes behind a competency. The NASUS will benefit from future work to identify relevant and reliable knowledge elements to include in order to fill out the breadth of the tool.

There are several limitations of the study. The pilot sample for the NASUS Survey included only 7 clinical agencies, all of whom participate in the CALOC Consortium. This sample may have an inherent bias that these clinical agencies are committed to improving patient outcomes and engaging in continuous quality improvement. Nevertheless, the scale was able to detect variance among the participants. Second, participation among the 41 units ranged from 1 participating nurse up to 15 participating nurses (1% to 42% unit rate). Voluntary participation holds no incentive for nurses to invest their time and energy into completing a survey. Recent research confirms decreasing rates of nurse participation in surveys.[86] Bedside nurses are required to complete a cadre of evaluations on a regular basis, and commonly suffer from what is known as "survey fatigue." Whether surveys are to assess safety culture, employee satisfaction, for benchmarking purposes (e.g. University Health Consortium agencies, or hospitals that have received Magnet status), or evaluations of clinical improvements implemented by leadership or educators, bedside nurses are besieged by surveys. Several CNOs who were invited to allow their nurses to participate in the pilot of the NASUS, declined, citing survey fatigue as a concern. With this variance in participation, it is imprudent to make any conclusions about practice context or culture from the pilot results.

Several items of the NASUS Scale need further testing for effective refinement. Question #4 of the Skills Subscale had a particularly low item-total correlation. The variability of how managers respond to error reporting may make this item unreliable in consistently contributing to the Skills Subscale. This question should not be eliminated, because reporting errors is paramount in tracking system gaps. Perhaps rephrasing the question using more objective language would improve the item's performance on

the NASUS scale. Questions 11, 12 and 14 in the Attitudes Subscale also had low item-total correlation and address the phenomenon of reporting errors. Because of the high number of subjective variables in error reporting, these questions may need to be reworded. [87] Questions 6, 7, 9 and 15 ask broadly worded questions regarding attitudes. Rephrasing these questions with more nuance may increase their consistency in the Attitudes Subscale. One may interpret the low item-correlation value for #13 to indicate that nurses who completed the NASUS scale feel strongly that nurses need to be included in reporting errors to a patient and family.

Conclusion

Although initial psychometric testing revealed acceptable reliability statistics, the NASUS Survey needs further refinement and piloting to enhance its utility in measuring nurses' attitudes and skills around updated safety concepts. Clinicians, administrators and researchers need to maintain awareness of the importance of attitudes and skills for safety competence. This pilot instrument initiates this area study. We plan on refining and retesting the NASUS instrument with hospital nurses. With an accurate assessment of nurses' skills and attitudes around updated safety concepts, yearly validation programs run at the agency level, continuing education offerings and targeted strategies can be implemented to address change fatigue, reluctance in engagement, or skills deficits.

CHAPTER III

NURSES' PERCEIVED SKILLS AND ATTITUDES ABOUT UPDATED SAFETY CONCEPTS: IMPACT ON MEDICATION ADMINISTRATION ERRORS AND PRACTICES

This chapter reports the results of aim two, examining the association between nurses' perceived skills and attitudes about updated safety concepts and MAE and adherence to safe medication practice rates. Upon completion of this pilot study, recommendations are made for future research examining these variables.

Background

Despite the landmark Institute of Medicine report over 15 years ago that alerted healthcare systems to pervasive occurrence of error in healthcare[1], adverse drug events (ADE) remain among the most frequently occurring adverse events in hospital patients.[88] Defined as injury resulting from medical intervention related to a drug[1], ADEs occur in approximately 2 million hospitalizations annually with resultant increase length of hospital stays, increase hospital costs, and increase risk of death.[89–91] ADEs can be categorized as injury resulting from adverse drug reactions, therapeutic failures, withdrawals or medication errors. Approximately 25% of ADEs are caused by medication errors and thus considered preventable ADEs; estimates range from 380,000 to 450,000 preventable ADEs occurring in US hospitals annually.[90]

In an effort to reduce ADEs, healthcare leaders and organizations have updated safety principles and practices, i.e., how errors are examined, understood and addressed.[59,60,92] System approaches and analyses to reduce medication errors and adverse drug events include strategies such as electronic health records (EHR), computer physician order entry (CPOE), bar code medication administration systems (BCMA), and structured prescribing forms.[72,92–95] Despite these strategies, ADEs, and more specifically medication errors, have remained a common occurrence.

One explanation for the lack of effectiveness in these system-level strategies is incomplete focus on the nursing role in medication errors. Approximately one-quarter to one-third of medication errors occur at the administration phase; medication administration is almost solely under the purview of the bedside nurse.[7] Yet, little is known about nurses' skills with updated safety practices or their attitudes about implementing these updated safety practices. Focusing on nurses' attitudes and skills with updated safety concepts may provide insight into the design and implementation of effective system- level and nurse-level interventions to minimize medication administration errors (MAEs).

Thus, the purpose of this study was to assess bedside nurses' perceived skills and attitudes about updated safety concepts. The specific aims were: 1) to describe nurse attitudes and perceived skills about updated safety principles and to explore associations between perceived skills and attitudes, and 2) to explore the influence of nurse perceived skills and attitudes on a) unit-level MAE rates and b) unit-level adherence to safe medication administration practices.

Methods

Conceptual Framework

Given the institutional and individual variables that impact unit-level MAE rates, this study used a conceptual framework adapted from the Outcome Production Framework (OPF) [59] and the Shimokura model of skepticism.[60] The OPF postulates that organizational characteristics, capital inputs and institutional process variables interact and influence clinician behaviors that in turn impact patient outcomes. Clinician behaviors may also be influenced by individual characteristics, including attitude.[59] Skepticism is a major element in assessing attitude and, in this study, reflects the degree to which nurses believe in the efficacy of evidence-based practice. [60] Skepticism is relevant to MAEs because the concept highlights not only an individual clinician's knowledge of evidence-based practice, but also any accompanying doubt of the guideline's effectiveness that may affect a clinician's sustained adherence to evidence-based practice.

Design

A cross-sectional study was conducted using two data sources: registered nurses employed at hospitals participating in the Collaborative Alliance for Nursing Outcomes (CALNOC) registry and CALNOC data on medication administration practices and medication errors. CALNOC is a not-for-profit, self-sustaining, national registry that oversees nursing- sensitive measures that are collected at the unit level of a hospital.[92] CALNOC was launched in 1996 and began as one of six American Nurses Association (ANA) pilot sites. CALNOC supports hospital collection of data on nursing-sensitive structure, process, and outcomes for benchmarking and quality improvement planning[92].

Human Subjects Review Committees at University of California San Francisco and Cedars-Sinai Medical Center, the Vanderbilt Institutional Review Board Committee and the Colorado Multiple Institute Review Board Committee (COMIRB) approved the study. Waiver of documented informed consent was granted. The introductory letter to both nursing leadership and nurses was explicit in stating that nurse participation was voluntary and anonymous, that there was no direct benefit of participation beyond contributing to nursing knowledge, and that the nurses would not be compensated.

Sample and Recruitment

This study targeted registered nurses (RNs) employed at hospital agencies that had participated in collection of MAE data via the CALNOC direct observation methodology within the eighteen months prior to the survey data collection timeframe (November 2014 to April 2015). CALNOC provided a list of 34 agencies that met the inclusion criteria. Three waves of inquiry emails and letters via the US Postal Service were sent to the Chief Nursing Officers (CNO) in these systems. Six agency CNOs agreed to participation, four declined participation and 24 did not respond. Once a CNO provided permission for agency participation, the PI (GA) contacted the CALNOC Site Coordinator to explain the study, identify appropriate target units and develop recruitment strategies for nurse participation. Target units were any inpatient adult or pediatric unit, or emergency department. Emergency departments were included since

many patients are kept up to 23 hours for observation and nurses frequently administer medications during observation.

CALNOC Site Coordinators sent out three waves of invitations to nurses, two weeks apart. The identified best date to launch the nurse-level survey was determined by unit managers or CALNOC Site Coordinators, as several targeted units were managing other quality and safety work with nurses (e.g., common barriers included preparation for Joint Commission visits or Ebola training and validations). One agency was lost to follow-up. The initial nurse sample consisted of 293 nurses from six agencies on 40 units. Employing a minimum 25% participation rate for unit inclusion criteria decreased the final sample to 15 units at four agencies, for a sample size of 159 nurses. Characteristics of the four agencies included: 75% presence of BCMA (n=3), 100% use of CPOE (n=4), 0% Magnet Status, 25% University Hospital Consortium (n=1), and 25% identification as an academic research center that partners with a local university (n=1). The types of units engaged in the study included: medical, surgical, obstetrics, emergency department, telemetry, neuroscience, rehabilitation, orthopedics, and ICU. Table 1 outlines the level of survey participation among RNs by unit and agency.

Table 1. Survey Participation Levels Among Registered Nurses (RNs) by Study Unit and Agency

Unit #	**Agency**	**% RN Participation**	**Sample Size**
1	A	26%	n=12
2	A	43%	n=10 **Agency A (n=22)**
3	B	35%	n=13
4	B	32%	n=11
5	B	31%	n=4
6	B	25%	n=9
7	B	26%	n=10
8	B	27%	n=7
9	B	38%	n=5 **Agency B (n=59)**
10	C	33%	n=15
11	C	26%	n= 18
12	C	30%	n=3 **Agency C (n=36)**
13	D	31%	n=11
14	D	26%	n=9
15	D	27%	n=11 **Agency D (n=31)**

Variables

The *Nurses' Attitudes and Skills around Updated Safety Concepts (NASUS*) Scale

The Nurses' Attitudes and Skills around Updated Safety Concepts (NASUS) Scale was developed to assess nurses' perceived skills and attitudes about updated safety concepts. The NASUS Scale adapted two existing scales (Schnall's Patient-Safety Attitudes, Skills and Knowledge - PS-ASK) Survey [93] and Chenot & Daniel's Health Professions Patient Safety Assessment Curriculum Survey [72]. The NASUS scale consists of two subscales: a perceived skills subscale (7 questions, e.g. ability to analyze a case to

find the cause of an error) and an attitudes subscale (17 questions, e.g. if there is no harm to the patient, there is no need to address an error), for a total of 24 questions. Each item of the NASUS employs a continuous visual analogue scale, ranging from 0 to 100. Cronbach's alpha reliability statistics for the whole NASUS Scale, the Skills Subscale, and the Attitudes Subscale are .73, .71 and .67 respectively. The development and pilot testing of the scale with 293 clinical RNs and psychometrics of the scale are described in Chapter II. [94]

Medication Administration Errors (MAE)

Unit-level MAEs are one of the primary outcomes of this study. CALNOC tracks MAEs using a standardized approach, the Medication Administration Accuracy Assessment [95]. This approach involves naïve observation whereby the trained observers do not know the actual medication order, but observe the entire preparation and administration process. The observers conduct a comparative record review to determine number, type of errors and frequency of each type of medication error.[95] Medication administration error types include the following 9 error categories: unauthorized drug error, wrong dose error, wrong form error, wrong route error, wrong technique error, extra dose error, omission error, wrong time error and drug not available error. [95] For each of these errors, observers document "yes" or "no." MAE results are tracked at the unit level, and data are reported as a monthly rate of error per 100 doses. [95] For this study, categories were combined for an overall MAE-free rate per unit.

Adherence to Safe Medication Administration Practices

The second outcome variable in this study was nurses' adherence to safe medication administration practices. This variable employs a direct observation methodology in CALNOC agencies. For each administered medication, observers compare the congruency of the nurse's practice to medication administration safe practices. These practices are: 1) compares medication with Medication Administration Record (MAR), 2) labels medication throughout the process from preparation to administration, 3) checks two forms of patient identification, 4) explains medication to patient and 5) charts medication immediately after the administration. Adherence is defined as the practices that met the

behavioral criteria divided by the total number of observed behaviors, times 100. Adherence to safe medication practices are tracked at the unit level. [95]

Data Analysis

IBM SPSS Version 23 was used for all analyses. NASUS data were collected and managed through REDCap (Research Electronic Data Capture), a secured web-based application designed to support data capture for research.[79] The NASUS Scale in REDCap was developed employing web-based strategies for ease of reading and ease of completion. CALNOC data were reported at the unit-level, were de-identified and then merged with nurse-level data on REDCap.

Collected data were examined for missing values, of which there was a minimum (less than 1%). No survey items were omitted from the analyses. Missing data were examined for patterns of recurrence or systematic problems. There was no pattern of missing data clustering around an agency or unit. To minimize bias, exclusion nurse criteria was any participant with three or more missing items.[80] Using these criteria, no nurse participants had to be removed from the sample. Each nurse's mean attitude subscale and mean perceived skill subscale was used to aggregate to the unit level. Descriptive statistics included frequencies for nominal data, and median, minimum and maximum values for continuous data due to skewed distributions and some very small sample sizes (e.g., < 10 nurses within some units). Spearman's rho coefficients were used for assessing correlations of attitude scores with skill scores, as well as for assessing correlations of unit-level aggregated nurse attitudes and skills with outcome variables. Unit-level attitude and skill scores were correlated with outcome variables, adjusting the standard errors for lack of independence. Those analyses resulted in essentially identical findings to those observed using the unit-level scores therefore only the results from the Spearman's rho approach are reported here. Unless specifically noted, an alpha of 0.05 was used for determining statistical significance.

Results

Aim 1: Nurse Attitude and Skill Subscales

Descriptions of the unit- and agency-level nurse attitude and skills scores are presented in Table 2. At the agency-level, the median of nurses' Attitude Subscale scores clustered around 67-68; unit median values ranged from 61 to 76. Within units, nurses' attitudes scores ranged from a minimal value of 31 to a maximum value of 86.

At the agency-level, the median nurses' perceived Skill Subscale scores ranged from 55 to 63; unit-level median scores ranged from 52 to 65. Within units, individual nurse means ranged from a minimal value of 33 to a maximum value of 92.

The strength of the association of the perceived Skills Subscale to the Attitudes Subscale was assessed. In addition to statistical significance ($p < 0.05$), Spearman's Rho correlation coefficients ≥.40 were considered clinically significant indicating 16% shared variability of the scores. In general, the pattern of the associations indicated that higher attitude scores were associated with higher skill levels. At the unit level, strength of correlations ranged from .03 to .61 with seven of the 15 units having clinically significant correlations ≥.40. Two of those associations were statistically significant with $r_s = 0.56$ and 0.59 Two very small units (n=4 and n=5) indicated inverse relationships ($r_s = -0.80$ and -0.40) between nurses' attitudes and skills. Neither were statistically significant. At the agency level, none of the associations were statistically significant and only one agency reached a clinically significant association between nurses' attitudes and perceived skills at $r_s = 0.40$.

Table 2. Descriptive Statistics and Correlations of Nurses' Attitude and Skill Subscale Scores Aggregated at the Agency and Unit-Levels

Unit #	Agency Unit	Attitude Median[a]	Attitude Min/Max	Skills Median	Skills Min/Max	r_s[b]
	AGENCY A LEVEL (n=22)	68	53/85	59	40/85	.40[c] (*p*=.068)
1	A (n-12)	69	53/82	65	42/85	.48[c] (*p*=.114)
2	A (n=10)	65	53/85	52	40/85	.23 (*p*=.532)
	AGENCY B LEVEL (n = 59)	67	30/85	63	34/86	.25 (*p*=.060)
3	B (n = 13)	67	56/80	63	39/78	.56[c]* (*p*=.049)
4	B (n = 11)	69	49/85	68	34/80	.03 (*p*=.937)
5	B (n=4)	69	67/81	66	61/80	-.80[c] (*p*= .200)
6	B (n=9)	76	31/80	61	43/86	.08 (*p*= .898)
7	B (n=10)	68	54/79	55	37/78	.18 (*p*= .627)
8	B (n=7)	65	50/68	63	47/82	.34 (*p*= .208)
9	B (n=5)	61	52/66	67	40/71	-.40[c] (*p*= .505)
	AGENCY C LEVEL (n=36)	68	36/86	63	35/92	.30 (*p*=.072)
10	C (n=15)	69	36/86	65	38/79	.59[c]* (*p*= .021)
11	C (n=18)	66	53/83	60	35/92	.09 (*p*=.723)
12	C (n=3)	71	58/75	59	54/67	1.00 (---)
	AGENCY D LEVEL (n=31)	68	49/80	55	33/84	.29 (*p*=.113)
13	D (n=11)	71	49/80	57	43/84	.49[c] (*p*= .285)
14	D (n=9)	64	59/73	55	33/82	.61[c] (*p*= .606)
15	D (n=11)	67	60/78	55	41/79	.37 (*p*= .259)

[a] Median values were based on nurses' mean scores. [b] r_s= Spearman's Rho [c] Clinically significant at r_s >= 0.40 (16% shared variance)

*=correlation statistically significant at the 0.05 level

Aim 2: Nurses' Attitudes and Perceived Skills on MAE and Adherence Rates

Table 3 displays the unit-level MAE-free rates and adherence to safe medication practice rates reported to CALNOC. Nine units reported error-free medication administration, and the remaining 6 units were observed with MAE-free rates ranging from 97% to 99%. Practice adherence rates were slightly more varied; three units were observed with 100% adherence rates and the other 12 units ranged between 84% to 99% practice adherence rates.

Table 3. Medication Administration Error (MAE)-Free Rates and Adherence to Safe Medication Practice Rates By Study Unit.

Unit	MAE Rate	Adherence
1	**100%**	**98%**
2	**100%**	**99%**
3	**98%**	**100%**
4	**99%**	**98%**
5	**100%**	**98%**
6	**100%**	**100%**
7	**98%**	**91%**
8	**100%**	**100%**
9	**100%**	**91%**
10	**99%**	**84%**
11	**100%**	**96%**
12	**100%**	**94%**
13	**99%**	**96%**
14	**97%**	**92%**
15	**97%**	**90%**

Associations of unit-level aggregated nurses' attitudes and perceived skills with their respective unit's MAE rates and practice adherence rates are summarized in Table 4. A clinically significant level of association was observed between nurses' perceived skills and MAE rates but it was not statistically significant (r_s=.47, *p*=.077).

Table 4: Correlation Statistics[a] for Unit-Level Aggregated Nurses' Perceived Skills Subscale and Attitudes Subscale Scores with their Respective Unit's MAE[b] rates and Safe Medication Practice Adherence (n=15 units)

	MAE Rates	**Adherence**
Attitudes Subscale	0.10 (p = .714)	0.11 (p=.687)
Skill Subscale	0.47 (p = .077)	0.32 (p = .241)

[a] r_s = Spearman's Rho [b]MAE = Medication Administration Error-Free Rates

Discussion

As a first step in examining methods for interventions to enhance safe medication administration practices, we examined nurse' attitudes and perceived skills related to updated safety concepts, and explored the extent to which these were associated with MAEs and safe medication administration practices. Our study found that 1) nurses' attitudes ranged appreciably at the individual level, but less so at the unit and agency level; 2) nurses had low perceived skills in updated safety concepts; 3) perceived skills, not attitudes, were clinically associated with MAEs; and 4) there was no clear pattern of association between nurses' attitudes and perceived skills.

There is a dearth of literature exploring nurses' attitudes about updated safety practices that affect their care delivery in the hospital setting. Much of the research about nurses' attitudes has focused on job satisfaction[96,97], or work environment.[98] Although updated safety models (e.g. human factors or safety science) are becoming increasingly common for examining adverse healthcare outcomes [99 100], research has yet to examine nurses' safety practices in terms of the competency framework of knowledge, skills and attitudes. Attitudes impact nurses' clinical decision making; nurses continuously prioritize work importance, based on their attitudes. [101] This study's finding of notable variability in nurse-level attitude scores, combined with the lack of research examining nurse attitudes about safety practices, invites further exploration.

At the agency-level, there was less variability in the Attitude Subscale median values, as well as a smaller unit-level range span, averaging 30 points between minimum and maximum values. The three

very small units in the sample (n=3, 4, 5) reported the smallest Attitude Subscale range span of 14 points. The fact that unit-level Attitudes Subscale values were not correlated with MAEs or adherence rates may be a reflection of the homogeneity of the sample.

Our study found that nurses had low perceived skills needed for implementing updated safety practices. The only item in the NASUS Skill Subscale in existing literature is nurses' willingness or reluctance to report errors or near misses.[102] Although tracking error data is paramount to improving systems, an updated understanding of safety in complex working environments identifies other skills that contribute to reduction of adverse outcomes. [103] The NASUS Skills Subscale explores other skills (e.g. identifying the cause of an error, discussing an error with a colleague, examining error trend data with aggregate data, and participating in a root cause analysis), which reflect a more complete approach to updated safety, and reflect the breadth of nurses' potential impact on safety outcomes. Similar to attitudes, there is a dearth of literature exploring nurses' skills in these areas.

An interesting finding of this pilot study is the clinical significance between participating nurses' perceived skills in updated safety concepts and MAE rates. This clinical association suggests that possibly the higher the perceived skills, the higher the accuracy in medication administration. The seven questions within the perceived Skills Subscale reflect four dimensions of safety practice: a) Reporting an error (items 1, 4), b) Analyzing an individual error (item 2), c) Discussing an error (items 3, 5), and d) Analyzing error phenomena in the microsystem (items 23, 24). Within these four dimensions are both nurse-level and system-level variables. This study suggests that MAEs are an interplay between system-level factors, as well as nurse-level factors. Further research may add further validation to this interplay. In understanding the interaction among differing levels of influence, leaders and educators can design more effective improvements to impact MAEs.

The described study found that there was no consistently clear association between nurses' attitudes and perceived skills. Five units demonstrated clinically significant positive associations between the Skills and Attitudes Subscales (units 1, 3, 10, 13 and 14). Unit 10 reported one of the sample's

strongest positive association between Skills and Attitudes (r_s=.59) and was also statistically significant (p = .021). But there were no results that suggested a clear pattern of these associations. Within the conceptual model of competence that employs the core components of knowledge, skills and attitudes, there is the understanding that an interdependence exists among these components in contributing to competence.[104] Evidence specific to the interplay between knowledge, skills and attitudes with pre-licensure nursing students' education around quality and safety is snowballing. These studies suggest that the wide-spread inclusion of QSEN competencies in nursing programs impacts students' sense of readiness to perform skills related to quality and safety and their awareness of systems-level variables in their practice.[105–107] Yet minimum evidence examines this multi-faceted approach to understanding quality and safety competencies with nurse clinicians. There is the possibility that with a larger sample of units an associative pattern may emerge.

The lack of variability and high values in the outcome data (MAE rates and Adherence to Safe Medication Administration Practices Rates) are encouraging data for the safety of our healthcare system. In CALNOC hospitals, reported data suggests nurses are systematic and attentive to unit standards in administering medications. One limit to these data is the unknown element of how many nurses are observed per 100 doses. Given the ubiquitous nature of medications in the hospital setting, 100 doses may be observed within a relatively short time period, with a limited number of nurses, and with a limited number of patients.

Limitations

This study relied on a voluntary survey design at a time when access to beside nurse clinicians is very difficult. In today's healthcare environment, nurses are both required and invited to participate in multiple surveys. Recent research confirms decreasing rates of nurse participation in surveys. [86] Nevertheless, in a sample of four agencies, 15 units had adequate participation to represent the scale data. The focus of the NASUS Scale may lend itself to biased self-reporting, as both the Skills Subscale and Attitude Subscale relied on nurses' reports of self-perceived attitudes and skills. Self-reported attitudes

and skills can be subject to bias if the content is considered sensitive or intrusive.[108] For nurses, reporting self-perceived attitudes and skills around patient safety may invite bias, as few nurses want to admit to unsafe attitudes or skills in their practice. Nevertheless, the reported data from the described study included healthy variability in its descriptive statistics. Nurses have great control over medication administration, however the MAE and Adherence Rates had limited variability, possibly reflecting a homogenous sample. However, a significant strength of the study was the collaboration with CALNOC, and access to data that is consistently and objectively measured in participating hospital settings, and represents actual safety practices.

Conclusion

The described research is the first pilot study to examine nurses' skills and attitudes about updated safety concepts and their impact on MAEs and adherence rates. An expanded assessment of nurses' attitudes and perceived skills in safety practices is imperative in identifying strategies to impact sustainable improvement with MAEs and other safety events.

Prior to the IOM report, safety was traditionally defined as an individual clinician phenomenon.[1] More recently, the pendulum has swung to safety lapses being understood as system gaps.[103] How nurses navigate the complex acute care healthcare environment is an intricate combination of knowledge, skills and attitudes, and medication administration demands are a significant portion of nursing's work. Future health systems research must reflect the emerging understanding that clinician adherence to updated evidence stems from knowledge, skills and attitudes and the interplay among agency-level, unit-level variables and nurse-level variables. [109]

CHAPTER IV

IMPLICATIONS FOR RESEARCH TRAJECTORY

The goal of this inquiry was to examine bedside nurses' perceived skills and attitudes specific to updated safety concepts, and explore how these nurse variables impact medication administration errors and practices. This study expands the existing evidence, as models that have guided MAE research have rarely considered clinician-level and system-level variables concurrently. The findings of aim one and aim two, utilizing an evolved conceptual framework, provide short-term and long-term suggestions for further study.

Gaps to Address

Short-term research trajectory

First, understanding competence in high risk work environments requires a conceptual model that reflects this complexity. The NASUS scale is based on a multi-variable model, and so begins this work. The development and validation of the NASUS scale demonstrated acceptable CVI results and Cronbach alpha values for the overall scale (∞ =.73), Skills Subscale (∞ = .73) and Attitude Subscale (∞ = .66). Nevertheless, further scale development and testing is required. The Attitude Subscale had the lowest Cronbach's alpha coefficient and several items will require revision and retesting.

Second, the conceptual model was used in a limited and rather homogenous sample. One-third of the participating units demonstrated a significant association between perceived skills and attitudes (r_s $\geq$.40). Measuring skills and attitudes together is an integrated approach to assessing human capital, which is supported by the results of this pilot study. Whether these results would remain consistent in settings other than CALNOC settings remain to be determined. The CALNOC agencies are more homogenous given their membership in this collaborative.

Third, integrated approaches to clinical competence acknowledge competence as a complex combination of knowledge, attitudes, skills, and personal values. [110] Progress in pre-licensure nursing curricula demonstrates the value of competence models that employ the three elements of knowledge,

skills and attitude; there is evidence that this model affects beginning clinicians' prioritization of safety standards in their practice.[111] The NASUS scale would be well served by inclusion of knowledge-level elements related to updated safety concepts. Given the bias inherent in self-assessment of knowledge, further research with input from experts in education and safety science will be necessary to develop viable knowledge items specific to updated safety concepts. Piloting and psychometric testing of these new scale items will be required similar to the Attitudes and Perceived Skills Subscales.

Last, in an effort to maintain anonymity, other nurse characteristics, such as age, educational experience, or clinical experience were not examined. Exposure to safety principles within individual units or organizations was also not examined. Given the dynamic nature of health care systems, determining these attributes may be the next step for the ongoing refinement of the conceptual framework used to guide this research.

Long-term research trajectory

The implications of safe practices, or not so safe, have substantial significance to the individual, health care system and society. The conceptual model developed and tested within the described research provides an integrated approach to assessing multiple levels of variables of the phenomenon of medication errors. Medication administration represents a perfect example of a complex activity where clinician, microsystem and agency-level variables influence each other and are interdependent. Other types of errors may not be as clearly delineated. For example, a number of hospital acquired conditions (e.g., pressure ulcers, nosocomial infections, and patient falls) are also influenced by patient-specific factors. The extent to which the conceptual model can be applied to other types of patient errors requires further examination. It may be that selected patient characteristics will be required in a comprehensive model that successfully predicts or provides direction in minimizing adverse outcomes. Health systems research approaches and tools must reflect this multi-level, complex reality. Understanding the correct leverage points in the context of clinical gaps (that can lead to adverse outcomes) may expedite important improvements. Additionally, findings from studies examining various facets of care may help direct effective priorities for continuing nurse education and skill validations within clinical systems.

Nurses' clinical decisions do not occur in a vacuum. The national QSEN initiative has laid groundwork in understanding how teaching early clinicians about updated safety concepts can impact these clinicians' professional values and clinical priorities.[112] There is a gap in the current research examining how clinicians whose education did not include the updated QSEN competencies have been cultivated so that updated safety concepts are cornerstones in their practice. This study begins to acknowledge this trend. Further assessment may examine elements from the model that are associated with sustained changes in practice that have long-term effects on improving systems.

Contributions to Science of Nursing

Complex phenomena, such as MAEs, are best studied with multi-level models. In examining outcomes that are largely under the auspices of the nurse, assessing attitudes is vital. In standardized definitions of attitude, the concept includes an affective component, which is impacted by one's values.[113] If a system improvement decreases a nurse's efficiency, but taps into this nurse's values about improving healthcare systems, there is a greater chance this nurse will adapt her practice for continued inclusion of this improvement, even if the improved process includes more steps or more time. Health systems research must consistently consider the human variables that impact implementation and sustainability of effective improvements.

Nurses are often at the core of implementing and sustaining system improvements. System improvements that reduce variability and increase standardization in medication administration are aimed specifically at impacting nurses' practice. Nurses' acceptance of new safety practices is often dependent on the advantages, feasibility and appropriateness of the improvement.[114,115] Changes that are adopted by nurses, and are sustained in nurses' practice relate to the perceived utility, and the individual nurse's perceived skills specific to the improvement.[116] Thus, studying nurses' perceived skills is a critical factor in identifying effective improvements, and this study begins important exploration of these interconnected phenomena.

APPENDIX A

Content Validity Index Survey
Patient Safety Expert Survey on Nurses' Knowledge Attitudes and Skills of Updated Safety Concepts

Dear Patient Safety Expert,

I am adapting two existing surveys to assess nurses' knowledge, skills and attitudes of updated safety concepts. The findings of this survey will help me determine how well bedside Med/Surg nurses have kept up with advances in safety concepts that have impacted healthcare environments in the last 15 years . I am currently seeking your help to establish content validity of this edited survey.

Target recipients: Bedside RNs in Med/Surg nursing units and Observational nursing units.

Survey Constructs

- Safety: Minimizes risk of harm to patients and providers through both system effectiveness and individual performance

The following pages include the survey items and responses, grouped by construct. Please rate each item on the following scale:

1. not relevant
2. somewhat relevant
3. quite relevant
4. highly relevant

Thank you for your consideration and sharing your expertise!

Sincerely,

Gail Armstrong
PhD student at Vanderbilt University School of Nursing

Content Validity Assessment
Nurses' Knowledge, Skills and Attitudes of Updated Safety Concepts

Survey Item and Response	**Content Validity Scale** **1.** Not relevant **2.** Somewhat relevant **3.** Quite Relevant **4.** Highly Relevant			
	1	**2**	**3**	**4**
Choose the number that corresponds to your <u>level of comfort</u> with doing the following:				
Accurately completing an incident report. Response: 5 point Likert Extremely Comfortable to Extremely Uncomfortable				
Analyzing a case to find the cause of an error. Response: 5 point Likert Extremely Comfortable to Extremely Uncomfortable				
Supporting and advising a peer who must decide how to respond to an error Response: 5 point Likert Extremely Comfortable to Extremely Uncomfortable				
Disclosing an error to a manager or supervisor Response: 5 point Likert Extremely Comfortable to Extremely Uncomfortable				
Disclosing an error to another healthcare professional Response: 5 point Likert Extremely Comfortable to Extremely Uncomfortable				
Choose the number that corresponds to your <u>level of agreement</u> with the following statements:				
Making errors in healthcare is inevitable. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Competent healthcare professions do not make errors that lead to patient harm. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Healthcare professionals should routinely spend part of their professional time working to improve patient care. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Healthcare professionals should not tolerate uncertainty in patient care.				

Survey Item and Response	**Content Validity Scale** **1.** Not relevant **2.** Somewhat relevant **3.** Quite Relevant **4.** Highly Relevant			
	1	**2**	**3**	**4**
Response: 5 point Likert Strongly Agree to Strongly Disagree				
The culture of healthcare makes it easy for healthcare professionals to deal constructively with errors. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Healthcare professionals routinely share information about medical errors and what caused them. Response: 5 point Likert Strongly Agree to Strongly Disagree				
In my clinical experiences so far, administrators communicate to me that patient safety is a high priority. Response: 5 point Likert Strongly Agree to Strongly Disagree				
In my clinical experiences so far, colleagues communicate to me that patient safety is a high priority. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Healthcare professionals routinely report medical errors. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Reporting systems do little to reduce future errors. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Physicians should be the healthcare professionals that report errors to an affected patient and their family. Response: 5 point Likert Strongly Agree to Strongly Disagree				
After an error occurs, an effective strategy is to work harder to be more careful. Response: 5 point Likert Strongly Agree to Strongly Disagree				
There is a gap between what we know as "best care" and what we provide on a day-to-day basis. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Learning how to improve patient safety is an appropriate use of time in my practice. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Effective responses to errors focus primarily on the healthcare				

Survey Item and Response	**Content Validity Scale** **1.** Not relevant **2.** Somewhat relevant **3.** Quite Relevant **4.** Highly Relevant			
	1	**2**	**3**	**4**
professional involved. Response: 5 point Likert Strongly Agree to Strongly Disagree				
If there is no harm to a patient, there is no need to address an error. Response: 5 point Likert Strongly Agree to Strongly Disagree				
If I saw a colleague make an error, I would keep it to myself. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Most errors are due to things that healthcare professionals can't do anything about. Response: 5 point Likert Strongly Agree to Strongly Disagree				
I have effective strategies in my practice to reduce my reliance on memory. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Standardized medication administration practices improve patient safety outcomes. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Standardized medication administration practices get in the way of my nursing practice. Response: 5 point Likert Strongly Agree to Strongly Disagree				
Choose the number that corresponds to your <u>level of competence</u> in the following skills:				
Participating as a team member of a Failure Mode & effect analysis. Response: 5 point Likert Extremely Competent to No Competence				
Interpreting aggregate error report data. Response: 5 point Likert Extremely Competent to No Competence				
Participating as a team member of a root cause analysis Response: 5 point Likert Extremely Competent to No Competence				
Choose the number that corresponds to your <u>level of knowledge</u> with the following items:				
Defining the characteristics of high reliability organizations.				

Survey Item and Response	**Content Validity Scale** **1.** Not relevant **2.** Somewhat relevant **3.** Quite Relevant **4.** Highly Relevant			
	1	**2**	**3**	**4**
Response: 5 point Likert Extremely Knowledgeable to No Knowledge				
Distinguishing among errors, adverse events, near misses, and hazards. Response: 5 point Likert Extremely Knowledgeable to No Knowledge				
Summarizing the published evidence about relationship between nurse staffing and patient outcomes (such as hospital morbidity and mortality, hospital-acquired pressure ulcers). Response: 5 point Likert Extremely Knowledgeable to No Knowledge				
Understanding basic concepts in human factors engineering that impact complex work environments. Response: 5 point Likert Extremely Knowledgeable to No Knowledge				
Safety –enhancing technologies (such as Computer Provider Order Entry and Bar Coding of Medications) prevent all errors Response: 5 point Likert Extremely Knowledgeable to No Knowledge				

APPENDIX B

Nurses **A**ttitudes and **S**kills with **U**pdated Safety Concepts Scale – NASUS Scale

Item	Question	Anchors
Skill Subscale		
Skill Subscale: Choose the number that corresponds to your level of comfort with the following:		
1	Accurately completing an incident report	0 = extremely uncomfortable 100=extremely comfortable
2	Analyzing a case to find the cause of an error	0 = extremely uncomfortable 100=extremely comfortable
3	Supporting and advising a peer who must decide how to respond to an error	0 = extremely uncomfortable 100=extremely comfortable
4	Disclosing an error to a manager or supervisor	0 = extremely uncomfortable 100=extremely comfortable
5	Disclosing an error to another healthcare professional	0 = extremely comfortable 100=extremely uncomfortable
23	Interpreting aggregate error report data	0 = extremely uncomfortable 100=extremely comfortable
24	Participating as a team in a root cause analysis	0 = extremely uncomfortable 100=extremely comfortable
Attitude Subscale		
Attitude Subscale: Choose the number that corresponds to your level of agreement with the following statements:		
6	Making errors in healthcare is inevitable	0= strongly agree 100 = strongly disagree
7	Competent healthcare professionals do not make errors that lead to patient harm	0 = strongly agree 100=strongly disagree
8	Healthcare professionals should routinely spend part of their professional time working to improve patient care	0 = strongly agree 100=strongly disagree
9	The culture of healthcare makes it easy for healthcare professionals to deal constructively with errors	0 = strongly agree 100=strongly disagree
10	Healthcare professionals routinely share information about medical errors and what caused them	0 = strongly agree 100=strongly disagree
11	Healthcare professionals routinely report errors	0 = strongly agree 100=strongly disagree
12	Reporting systems do little to reduce future errors	0 = strongly agree 100=strongly disagree
13	Physicians should be the healthcare professionals that report errors to an affected patient and family	0 = strongly agree 100=strongly disagree
14	After an error occurs, an effective strategy is to work harder to be more careful	0 = strongly agree 100=strongly disagree
15	There is a gap between what we know as "best care" and what we provide on a day-to-day basis	0 = strongly agree 100=strongly disagree

16	Learning how to improve patient safety is an appropriate use of time in my practice	0 = strongly agree 100=strongly disagree
17	If there is no harm to a patient, there is no need to address an error	0 = strongly agree 100=strongly disagree
18	If I saw a colleague make an error, I would keep it to myself	0 = strongly agree 100=strongly disagree
19	Most errors are due to things that healthcare professionals can't do anything about	0 = strongly agree 100=strongly disagree
20	I have effective strategies in my practice to reduce my reliance on memory	0 = strongly agree 100=strongly disagree
21	Standardized medication administration practices improve patient safety outcomes	0 = strongly agree 100=strongly disagree
22	Standardized medication administration practices get in the way of my nursing practice	0 = strongly agree 100=strongly disagree

APPENDIX C

Letter of Invitation to RNs on Targeted Units

Dear RN,

Healthcare leaders are seeking to improve the safety of healthcare, and nurses have important contributions for these improvements. ***We need more nurses' voices at the table to contribute to improvement efforts.*** *My name is Gail Armstrong and I am writing to recruit your participation in a very quick survey. I am a PhD student at Vanderbilt University and am studying nurses' skills and attitudes towards updated safety concepts.*

Recent nursing research suggests that an understanding of updated safety concepts impacts nurse-level practice, but this research has only been done on nursing students. I am collecting these data at your hospital to expand the scope of this research question. My study has been approved by CALNOC, The Vanderbilt Internal Review Board (IRB), the Colorado Multiple Institute IRB and has been approved by nursing leadership at your facility.

Your participation is totally voluntary. There is minimal risk to participation as the data is only collected at the unit level and will remain confidential and anonymous. ***Completing the survey will take less than 10 minutes.*** *There is no direct monetary or compensatory benefit to participation in this study. Similarly there is no risk as unit level management will never be informed of which nurses did or did not participate.*

Data is collected via a secure web platform called REDCap. The following url will directly connect you to this survey: https://redcap.vanderbilt.edu/surveys/?s=cdhZ8RxRR4

Your completion of the survey indicates your consent to participate in this research study. If you have any questions concerning your rights as a research subject, please contact the Vanderbilt University IRB office at (615)322-2918. If you have concerns regarding this research, please contact me at the email below or at my cell phone number: (720)339-7610.

Please consider participation. Nurses' participation is vitally needed and these data will be used to demonstrate current nursing knowledge of patient safety, and direct future educational initiatives for bedside clinicians.

Many thanks for your time and consideration.

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