

A DESCRIPTIVE, CORRELATIONAL STUDY OF MEDICATION ADMINISTRATION
TIMING ERROR PREVALENCE IN ACUTE CARE, UNDERREPORTING
AMONG ACUTE CARE NURSES, AND THE CORRELATION
TO PATIENT SAFETY CULTURE

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by
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ABSTRACT

Background. Medication administration timing errors are associated with patient harm. Complicated by underreporting, accurate rates have been elusive. Correlation with patient safety culture is unknown.

Purpose. Guided by high reliability organization theory, this study aimed to describe individual and unit prevalence of time-critical and non-time-critical medication administration timing error and its underreporting as reported by acute care registered nurses and identify the correlation to patient safety culture.

Methods. Using a descriptive, correlational design, acute care registered nurses were recruited using random and online convenience sampling. A survey measured frequency and underreporting of individual and unit-level time-critical and non-time-critical medication administration timing error. The Hospital Survey on Patient Safety Culture version 2.0 measured patient safety culture.

Results. Of 720 participants, 259 remained following data cleaning. Participants were primarily female (55.2%, n=143), bachelor's educated (51%, n=132) with a mean age of 32.7 years (SD=82). Regarding time-critical timing error, 35.1% reported at least a 50% individual error rate and that 23.9% of their units "Never/Rarely/Occasionally," administered medications

on time. For non-time-critical, these rates were 40.5% and 31.6%, respectively. Regarding underreporting time-critical timing error, 47.5% underreported at least 50% of individual errors, and 44.8% of their units “Never/Rarely/Occasionally” reported timing errors. For non-time-critical, these rates were 52.1% and 49.8%, respectively. Significant weak correlations were identified between fewer reported timing errors and multiple dimensions of patient safety culture, the strongest was teamwork for unit-level time-critical medications ($\rho = .263, p < .01$). Underreporting had significant weak correlation to multiple dimensions of patient safety culture except for individual non-time-critical medications, the strongest was unit level reporting of time-critical medications ($\rho = .295, p < .01$).

Discussion. A varied rate of timing error was discovered with the upper end alarmingly high, consistent with previous research. Additionally, a high rate of underreporting was identified. Lower timing errors and underreporting are associated with improved patient safety culture.

Conclusion. This study was the first to examine underreporting of timing error and the correlation to patient safety culture to error and its reporting. Lower timing error and underreporting are associated with improved patient safety culture. This study provides robust evidence to advance research, practice, policy, and theory.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the School of Nursing and Health Studies, have examined a dissertation titled “A Descriptive, Correlational Study of Medication Administration Timing Error Prevalence in Acute Care, Underreporting among Acute Care Nurses, and the Correlation to Patient Safety Culture,” presented by Trinity J. Pullam, candidate for the Doctor of Philosophy degree, and hereby certify that in their opinion it is worthy of acceptance.

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CHAPTER 1

INTRODUCTION

This chapter introduces key concepts, research questions, and the guiding nursing theory utilized in this study. Included are an examination of medical error, specifically medication administration timing error, followed by a closer discussion of medication administration timing error's definition. Also presented are examination of medication administration timing error underreporting and patient safety culture. Finally, the purpose of this study, its research questions, and a discussion of its guiding theory are presented.

Medical error is associated with poor health outcomes and high costs to individuals and institutions (World Health Organization, 2023). The definition of medical error varies among researchers, nurses, and health providers. Definitions of medical error include unintended acts, missed care, wrong plan of care, or deviation from the care process (Makary & Daniel, 2016) and the failure of a planned action or use of a wrong plan (Kohn et al., 2000). Grober and Bohnen (2005) noted that, historically, the definition of what constituted a medical error has often been based on outcomes rather than process.

In 1999, the Institute of Medicine published the report *To Err is Human: Building a Safer Health System*, which identified that 44,000 to 98,000 patient deaths could be attributed to medical error annually (Kohn et al., 2000). James (2013) performed a systematic review of studies related to medical error harm, including studies published between 2008 and 2011. The review estimated a minimum of 210,000 deaths and greater than 400,000 incidents of patient harm within the hospital setting due to medical error. In 2016, medical error was estimated to be the third leading cause of death in the United States (Makary & Daniel, 2016). While this was considered by some as an overestimation, even more conservative estimates point to a

concerning trend and include 123,603 United States medical event deaths between 1990 and 2016 and more than 22,000 annual deaths in the United States (Rodwin et al., 2020; Sunshine et al., 2019).

Medication error, a specific type of medical error, occurs more frequently in the hospital than any other type of medical error (Wondmienieh et al., 2020). The National Coordinating Council for Medication Error Reporting and Prevention (2022) defines medication error as any preventable event that can lead to harm or inappropriate medication. Medication error is associated with increased morbidity and mortality (van den Bemt et al., 2002).

Medication error is a common cause of adverse events around the world. Over 7,000 deaths per year in the United States can be attributed to medication error (Choi et al., 2016). The United States spends as much as \$40 billion annually due to medication-associated error (Tariq et al., 2021). Likewise, in the United Kingdom, approximately 20% of preventable hospital deaths are due to medication error (Leufer & Cleary-Holdforth, 2013). The cost of medication error in Australia is estimated at 1.2 billion Australian dollars (\$884 million American) (Roughead et al., 2016). Eleven percent of medication error in an Australian study was associated with severe patient harm resulting in permanent harm, death, or increased hospital length of stay (Roughead et al., 2013).

The process of medication administration is complex and, therefore, fraught with opportunities for error (Hughes & Blegan, 2008). Firstly, the appropriate healthcare provider must order or prescribe a medication correctly. A prescription error occurs if omitted, unclear, or conflicting information happens during the ordering process (Cho et al., 2014). Secondly, medications must be administered correctly. An administration error occurs when the wrong medication is given, the wrong route is used, the medication is given at the wrong time, or

incorrect instructions or processes occur. Finally, all medication administration must be correctly documented. If documentation is missing or incomplete, an error in documentation has occurred. Due to this complex process, medication error can occur during any phase of the medication process and can result from error by the provider creating the order, the nurse who administers the order, or even the pharmacist who supplies the medication (Tariq et al., 2021).

Medication administration timing error, a type of medication administration error, occurs when a medication is administered before or after a prescribed administration time. For example, if a patient with an infection is prescribed the antibiotic piperacillin/tazobactam 3.375 grams intravenously every six hours, and the next dose is scheduled for 6:00 a.m. but not administered until 8:00 a.m., the medication is considered late if the unit allows medications to be administered 60 minutes before or after the ordered administration time. Because the medication was administered late, it is a medication administration timing error. If the piperacillin/tazobactam 3.375 was ordered for 12 p.m. and then administered early at 10:30 a.m. on the same unit, the medication given early is a wrong time medication administration error, as well. Medication administration timing error is often cited as the most common type of medication error, though the reported prevalence rate varies widely from 1% (Noguchi et al., 2016) to 72.6% (Berdot et al., 2012).

When a medication is not administered at the prescribed time, poor medication efficacy or patient harm can occur (Gunningberg et al., 2014). Medication efficacy refers to the ability of a medication to produce the desired effect (Lynch, 2022). Medication effectiveness occurs when that efficacy continues in real-world patient care. When medications are given outside of their therapeutic administration window, they provide less than desired effects for the patient.

Medication administration timing error has been linked to severe harm and death, especially in high-alert medications such as antithrombotics, insulins, and opioids (van den Bemt, 2002).

Medication Administration Timing Error Definition

Medication administration timing error is most frequently reported as medications administered outside an allotted timeframe. Outside of this timeframe is commonly identified as more than 60 minutes before or after the scheduled or prescribed time (Berdot et al., 2012; Feleke & Girma, 2010). Other definitions of wrong time medication administration error include administration two hours before or after the scheduled dose of medication that is ordered daily or less frequently than daily (Blignaut et al., 2017) or administering a subsequent dose too close to the initial dose of a new medication (Idemoto et al., 2015).

Timing of medication is frequently discussed as one of the five necessary “rights” for the correct administration of medications along with the right patient, drug, dose, and route (Billstein-Leber et al., 2018; Blignaut et al., 2017; Hammoudi et al., 2018; Stetina et al., 2005; Wondmieneh, 2020). Ensuring that medications are being administered at the right time is an essential function of medication administration.

Time-critical Medications

The Institute for Safe Medication Practices (ISMP) recommends that acute-care facilities identify and establish guidelines for time-critical medications (Institute for Safe Medication Practices, 2011). Time-critical medications may result in harm or inadequate treatment if administered more than 30 minutes before or after the scheduled time. Medications that are non-time-critical are less likely to cause harm from early or late administration, and generally, administration can be safely achieved one to two hours before or after scheduled time. Time-critical medications are at increased risk of medication administration timing error due to the

shorter time-frame for administration (Loput et al., 2022). Furnish et al. (2021) found a statistically significant difference in the on-time administration of time-critical medications at 69% as compared to non-time-critical medications at 84%.

Within the United States, acute-care facilities must follow the Center for Medicare and Medicaid Services (CMS) guidelines for developing and evaluating a timing policy for medication administration (State Operations Manual – CMS, 2020). The CMS guidelines allow facilities to consider the complexity of medication administration when developing a medication timeframe but require that facilities have a plan for scheduled, non-scheduled, and time-critical medications. Time-critical medications are scheduled more frequently than every four hours or are identified as time-critical in the facility administration policy. Time-critical medications must be given within a 1-hour timeframe of scheduled dosages (30 minutes before or after the prescribed time) because an early or late administration can lead to harm. Medications that are not time-critical may be given a longer administration timeframe of two hours or given a timeframe of four hours if the medication is given daily or less frequently (State Operations Manual – CMS, 2020). Additionally, CMS guidelines require hospital policies to be consistent with accepted standards based on guidelines or recommendations from nationally recognized organizations.

Medication Administration Timing Error Underreporting

Although evidence demonstrates that medication administration timing error occurs commonly in acute care (Pullam et al., 2023), the extent of the issue remains unclear due to underreporting (Scott & Henneman, 2017). In a survey of 53 nurses, the largest percentage (43.9%) of respondents estimated that only 25% of medication errors were reported, and only 5.3% of nurses estimated that all medication errors were reported (Osborne et al., 1999). Several

factors lead to underreporting of medication administration timing error. These factors are discussed below.

Despite spending 40% of work hours administrating medications (Armitage & Knapman, 2003), nurses may lack understanding or willingness to participate in safety initiatives to reduce medication error (Leufer & Cleary-Holdforth, 2013). While this lack of knowledge is often seen as a personal deficit, a lack of appropriate education and support at an organizational level often exacerbates this issue. Organizations may lack focus on or are unwilling to fully acknowledge the extent of medication error problems. This lack of understanding and common definition means that identification and measurement of medication administration timing error is plagued by underreporting.

Fear is a common barrier to medication error reporting (Soydemir et al., 2017). Nurses often hesitate to report error due to fear of blame, continued scrutiny by other healthcare workers, and loss of position due to their mistake. Additionally, lack of feedback or receiving negative feedback following error reporting is adversely related to reporting.

Another factor affecting medication timing error reporting is personal judgment (Scott & Henneman, 2017; Soydemir et al., 2017). Underreporting can transpire as nurses may use personal judgment instead of policies to determine if an error has occurred and whether to report errors (Scott & Henneman, 2017). Nurses may feel that if no harm is identified, a late medication does not need to be reported (Soydemir et al., 2017). This use of personal judgment, rather than policy, can lead nurses to underreport medication timing errors if they perceive them as unimportant.

Lack of a sufficient reporting system or education on the reporting process also leads to poor compliance with reporting practices (Soydemir et al., 2017). Organizations may have

inadequate procedures and education in place. Nurses may be unaware that a reporting system exists, be unsure of their ability to navigate it, or not have the time required to utilize a poorly designed system.

Finally, Stetina et al. (2005) found that medication administration timing policies were consistently considered less important than other medication administration rules. This lack of adherence to policy, coupled with the lack of reporting of medication timing error, leads to a lack of safety culture.

Patient Safety Culture

A safety culture prioritizes the patient's safety as a goal (Kohn et al., 2000). An organization with a strong patient safety culture fosters patient safety by promoting and encouraging shared standards, values, and actions of all staff throughout every level of the organization (Agency for Healthcare and Quality, 2022). Measurement of patient safety culture can be achieved by identifying which standards, ideas, behaviors, and customs are expected, supported, and rewarded within an organization (Agency for Healthcare Research, 2022). Safety culture should include effective leadership, respect for human limits, promotion of team functioning, anticipation of the unexpected, and a learning environment (Kohn et al., 2000). Additionally, an authentic safety culture minimizes fear of blame as organizations focus on systemic improvement needs rather than individual deficits.

Error can result from a lack of safety culture in personal attitudes or organizational structure (Metsälä & Vaherkoski, 2014). If a safety culture is not in place, neglect of policies and procedures, incorrect practices, deliberate negligence, as well as fear of punishment for reporting error can result. Metsälä and Vaherkoski (2014) found in a systematic review of medication errors in acute care elderly clients that a safety culture that allows for multi-professional

teamwork, practices to reduce distractions and improper procedures for medication administration, and a commitment to safe practices, especially by leadership, improves the medication process.

Currently, a significant gap in the literature exists on the prevalence of medication administration timing error and its reporting. The literature on the prevalence of medication administration timing error remains in the descriptive stage due to heterogeneity between studies (Pullam et al., 2023). Additionally, the connection between reporting of medication administration timing to patient safety culture has not been explored in past studies. Underreporting of error occurs frequently due to many factors; however, the rate of underreporting of medication administration timing error has yet to be identified (Osborne et al., 1999; Soydemir et al., 2017). Despite the importance of these topics in healthcare, a knowledge gap continues to exist. This study helps narrow the gap by providing an improved description of the prevalence of medication administration timing error, providing a novel description of prevalence of medication administration timing error reporting, and through a novel exploration of the correlation of medication administration timing error and medication administration timing error reporting to patient safety culture.

Purpose

This study's purpose is to describe the individual and unit prevalence of medication administration timing error and its underreporting for both time-critical and non-time-critical medications as reported by acute care nurses and to identify the correlation between patient safety culture as reported by acute care nurses and the prevalence of these errors and underreporting.

Research Questions and Hypotheses

This study aimed to answer the following research questions (RQ):

RQ#1: What is the individual and unit prevalence of medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units?

RQ#2: What is the individual and unit prevalence of underreporting medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units?

RQ#3: What is the correlation of individual and unit prevalence of medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units with patient safety culture?

H1: A correlation exists between the individual and unit prevalence of time-critical and non-time-critical medication administration timing error in acute care units and patient safety culture as reported by acute care nurses in those units.

RQ#4: What is the correlation of individual and unit prevalence of underreporting medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units with patient safety culture?

H1: A correlation exists between the individual and unit prevalence of underreporting time-critical and non-time-critical medication administration timing error on acute care units and patient safety culture as reported by acute care nurses on those units.

Theoretical Framework

This study was guided by high reliability organization (HRO) theory. An HRO is a high-risk, complex, and potentially harmful organization that can reliably operate without catastrophic

error (Weick & Sutcliffe, 2015). Reliability refers to the ability of the system or organization to produce expected results (Gaw et al., 2018).

The theory was originally developed to explain processes to provide system reliability and was used within businesses such as aircraft control and nuclear power plants but has recently been adopted by healthcare organizations (Chassin et al., 2015; Oster et al., 2016). In complex and high-risk healthcare systems such as acute care hospitals, the aim toward zero harm requires that organizations focus not only on obvious harm but on all preventable harm (Oster & Braaten, 2021). An organizational culture of safety is paramount to the success of HROs.

Central to HRO theory is the idea of collective mindfulness, or a system in which all workers are involved in identifying and reporting small and potential risks prior to those risks becoming substantial (Chassin, 2015). The theory component includes the meticulous use of a consistent improvement process, a culture of safety throughout an organization, and a commitment to teamwork within the organization (Veazie et al., 2019). To remain effective, HROs encourage error reporting and recognize failures and errors as a sign of systematic weakness regardless of whether an incident appears isolated (Weick et al., 2000a).

The infrastructure of HROs includes processes and procedures that create reliability while allowing for adaptation and learning (Weick et al., 2000b). Utilizing HRO theory principles can provide the ability to function safely despite complexity and risks (Sutcliffe, 2011).

Five HRO theory principles provide guidelines for achieving an HRO and avoiding catastrophic failures despite a complicated and turbulent system (Chassin, 2015). The core principles of HRO theory are a preoccupation with failure, reluctance to accept simplification,

deference to expertise, sensitivity to operations, and commitment to resilience (Weick & Sutcliffe, 2015).

An HRO's preoccupation with failure requires organizations to continuously look for potential hazards prior to their occurrence (Oster et al., 2016). Rather than only identifying errors that have already occurred and have caused harm, HROs work to anticipate and avert system failures, allowing organizations to identify potential consequences and work toward preventing possibly harmful failures. High reliability organizations expect smaller failures to occur but seek to improve operations through understanding and focus on that improvement, thus preventing catastrophic failure within the system itself. An HRO views performance measurement as one of the key ingredients in evaluating the organization's efficiency and effectiveness (Sutcliffe, 2011).

Additionally, HROs are reluctant to accept simplification as they recognize that the simple solution is not always the best (Oster et al., 2016). An HRO typically utilizes system approaches that include complex steps to prevent human error and considers day-to-day activities. The HRO views failures that occur as effects of breakdowns of the system. Complex healthcare systems have multiple interrelated aspects, and simple processes often cannot address issues within those systems.

Highly reliable organizations also defer to expertise and thus value the input from experts at every level (Oster et al., 2016). Interprofessional collaboration and open communication can increase the efficiency of an organization by allowing expert input into complex solutions and processes while enabling open communication among all parties to streamline operations. Rather than authoritative control, HRO leaders look to those with adequate experience and expertise when identifying and addressing system issues.

Sensitivity to operations requires an HRO to recognize the importance of daily processes and, thus, the importance of front-line workers (Oster et al., 2016). Those front-line workers better understand the organization's typical day-to-day operation and can identify potential issues with current procedures and changes to the system. Both front-line staff and management should be consistently aware of the system's performance. Standardization of processes can help to create less variability, but input from those who work in the daily operations must be considered to allow for individualization when needed. An additional aspect of the principle of sensitivity to operations is the requirement of organizations to recognize and evaluate ineffective procedures and how front-line workers must adapt to achieve essential work (Oster & Braaten, 2021).

Finally, an HRO's commitment to resiliency allows for failures within the system to be non-punitive and to be seen as opportunities for improvement (Oster et al., 2016). Within HROs, adverse events should be quickly recognized and mitigated. An HRO focuses on high-quality training and education to ensure that those within the system understand how to proceed when failures occur.

Healthcare organizations must deliver high-quality, safe patient care (Gaw et al., 2018). A highly reliable healthcare organization provides safe care and minimizes error through focused training (Gauthier et al., 2006). In order to achieve the reliability that other HRO organizations can, healthcare settings must focus on skilled leadership, ensure a culture of safety, and have a robust performance improvement process in place (Gaw et al., 2018). Clinical leaders must ensure that decisions continue supporting or improving quality and safety in patient care. Additionally, all team members must understand the importance of safety and quality and ensure

that those features continue. Finally, performance improvement methods must consider the complexities of each system and utilize robust processes.

Within HROs, employees feel psychologically safe and engaged with the quality goals of the organizations (Gaw et al., 2018). Leaders within HROs must respect employees and acknowledge their expertise and skills. Employees should be rewarded for reporting mistakes, conveying potential issues, and communicating ideas. Leaders can establish organizational culture by supporting employees and encouraging a safety culture. HROs promote mindfulness for all employees, allowing for awareness of potential and actual issues, and support open communication between all team members.

High reliability organization theory shifts the focus of organizations from reactive to proactive. Potential safety issues are identified, evaluated, and corrected prior to catastrophic failures (Oster & Braaten, 2021). In order to develop into a high reliability organization within healthcare, hospitals must create strong foundations (Agency for Healthcare Research and Quality, 2019). A positive safety culture is a fundamental building block for achieving a high reliability organization (Oster & Braaten, 2021).

Conclusion

This chapter included definitions of medical error, medication error, medication administration timing error, and safety culture. Also included was a discussion of possible factors for underreporting medication administration timing error and the study purpose, research questions, and hypotheses. Finally, a discussion of the guiding theory of this study was included.

CHAPTER 2

REVIEW OF LITERATURE

This chapter summarizes the state of literature about the frequency of medication administration timing error. Details of the search methods, results, and indications are discussed below.

Makary and Daniel (2016) identified medical error—any unintentional act related to medical care—as the third leading cause of death in the United States. Patients experiencing medical error are at a higher risk for adverse events, poor outcomes, and longer hospital and intensive care stays (Ahmed et al., 2015). Medical error is so common in nurses' daily routine that despite the propensity for patient harm, it is seen as an inherent part of nurses' daily routine (Duarte et al., 2015). Medical error was linked to 123,603 deaths between 1990 and 2016 (Sunshine et al., 2019). Medical events cause over 22,000 U.S. deaths annually (Rodwin et al., 2020). The total number of medical error-related deaths is likely underreported on death certificates due to a lack of medical event reporting.

In acute care settings, the most common type of medical error is medication error. Medication error are medical errors related to medication use that can result in inappropriate medication administration or adverse patient outcomes (Billstein-Leber et al., 2018; Wondmieneh et al., 2020). Nurses are at the forefront of medication errors, spending around 40% of their working hours administering medications (Armitage & Knapman, 2003). Medication error in the United States contributes to more than 7,000 deaths and an economic burden of more than \$26 billion annually (Choi et al., 2016; Blignaut et al., 2017). Medication error is a global issue. For example, in Australia, severe patient harm is associated with 11% of medication errors that occur, and in the United Kingdom, 20% of preventable hospital deaths are associated with

medication error (Blignaut et al., 2017). Alarming, in a meta-analysis of 23 studies that span many countries, Patel et al. (2022) identified the mean percentage of drug-related deaths (either from adverse events or medical error) as 5.6%. Of those, the preventable drug-related death rate was 45.2%.

Medication administration timing error is a more specific type of medication error that occurs when a medication is administered outside of an allotted timeframe. For example, on a unit with a medication timing policy requiring medications to be administered within 60 minutes of the scheduled time, a nurse who administers a patient's 9:00 a.m. antibiotic after 10:00 a.m. would have committed a medication error. When medication is not administered when scheduled, it can lead to poor medication efficacy and patient harm (Gunningberg et al., 2014). Though often thought of as a benign error, harm and death from medication administration timing error has occurred and is more likely with high-alert medications such as antithrombotics, insulins, and opioids (van den Bemt et al., 2002).

Medication administration timing error is a complex issue. Consequently, many factors must be considered when trying to solve this problem. Nurses may still not understand how critical correct timing is to medication administration or may not be willing to participate in medication safety initiatives, even though administering medications consumes much of their work time (Leufer & Cleary-Holdforth, 2013). Additionally, there may be hesitation to acknowledge the extent of the problem, a lack of initiative to improve, or inadequate education or support at the organizational level. As such, the extent of the problem is often not well-known due to underreporting in medical-surgical settings (Scott & Henneman, 2017). Nurses often use judgment over facility policy when deciding whether a medication error has occurred (Biffu et al., 2016; Stetina et al., 2005).

A medication administration timing error occurs when medication is administered outside of an allotted timeframe as defined by a facility policy (Pullam et al., 2023). No standard timeframe has been set across facilities, but within the United States, facilities must have a plan for scheduled, non-scheduled, and time-critical medications utilizing recommendations from nationally recognized organizations (State Operations Manual – CMS, 2020). Scheduled medications are those that are prescribed on a repeated frequency, such as daily, twice daily, or more frequently. Non-scheduled medications may be those that are ordered on an as-needed basis, one-time basis, first-time, or procedure-based. Time-critical medications are those that must be given in a much more specific timeframe, as an early or late administration of greater than 30 minutes might cause harm or have a significant negative impact on the therapeutic or pharmacological effect of the medications. The administration of medications on time is considered one of the five necessary rights of medication administration (Billstein-Leber et al., 2018; Blignaut et al., 2017; Hammoudi et al., 2018; Stetina et al., 2015; Wondmienen et al., 2020).

Next, a review of literature is presented. This includes a previously published systematic review titled “Frequency of Medication Administration Timing Error in Hospitals: A Systematic Review” published in the *Journal of Nursing Care Quality* (Pullam et al., 2023). The text from the publication has been updated with results from a systematic review of the literature for the years March 2021 to June 2024 using the same search terms and databases.

Methods

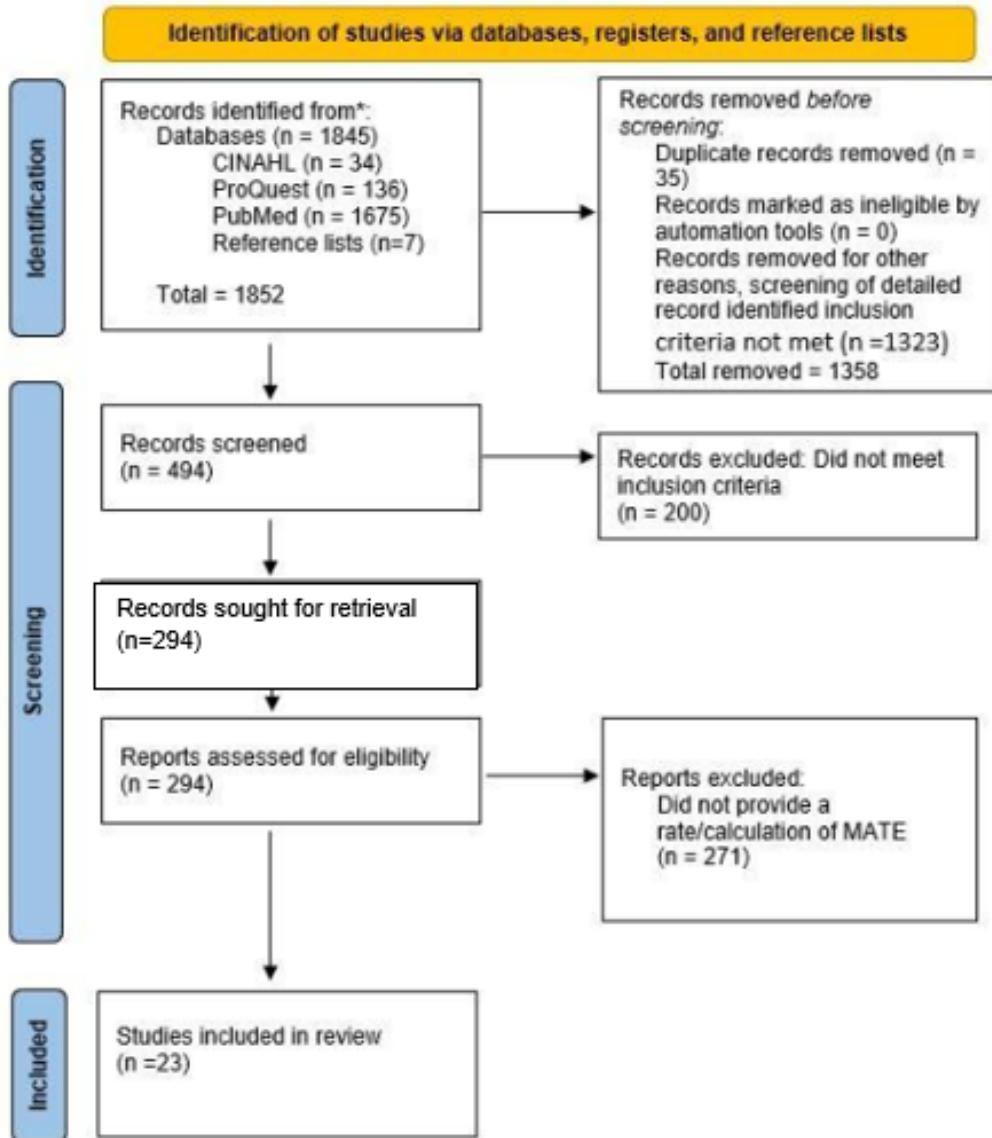
Two separate reviews were completed. A report of the first review titled “Frequency of Medication Administration Timing Error in Hospitals: A Systematic Review” was published in the *Journal of Nursing Care Quality* (Pullam et al., 2023). After completing the second literature

search, the search results were combined for analysis of finding to present in this paper. The first literature review was completed following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 checklist and guidelines (Page et al., 2021). The databases searched were the Cumulative Index of Nursing and Allied Health Literature, ProQuest, and PubMed using the following search terms: inpatient and medication administration timing error, wrong time medication, medication timing, late medication, and “wrong time” medication. The dates included were January 1999 through February 2021. The initial date was chosen to begin the date that *To Err Is Human* was published in 1999, as this punctuated the state of medical care error and its risk to patients (Kohn et al., 2000). The inclusion criteria were full-text peer-reviewed journal articles of primary research, inpatient inclusion of a calculation of medication timing error, and published in English. Additional published studies meeting inclusion criteria were included by searching article references.

The second literature search utilized the same search terms, inclusion criteria, and databases. The date range for the search was March 2021 through May 2024 to capture any update to the scientific body of evidence since the publication of the previous systematic review of the literature (Pullam et al., 2023). The first author (T.P.) screened all records. Using the flow diagram developed by Page et al. (2021), Figure 2.1 provides a flow diagram of the record review, yielding 23 articles in the first review. Likewise, using the same flow diagram, Figure 2.2 provides a flow diagram of the record review, yielding six articles in the second review. A table summarizing all articles included in this review of literature can be found in Appendix A.

Figure 2.1

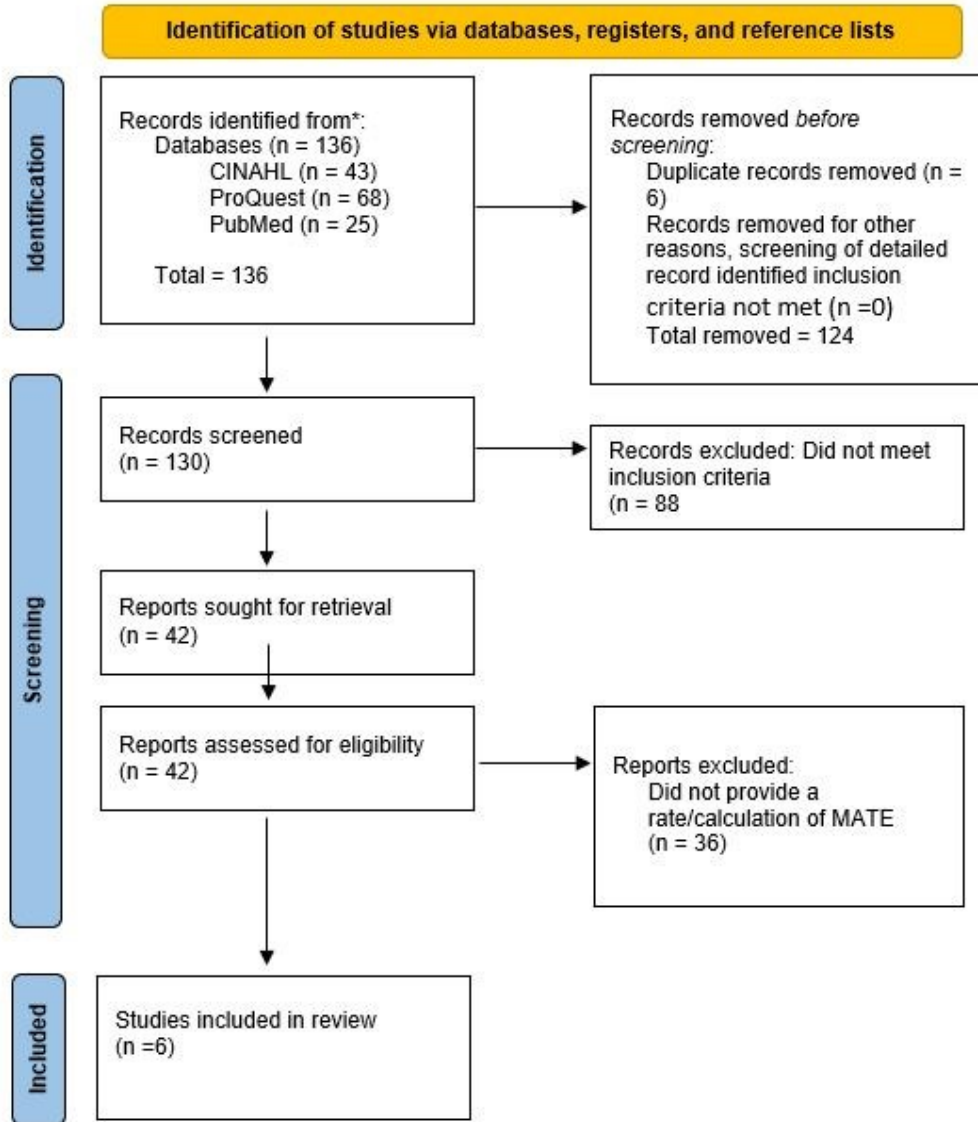
Flow Diagram of Search 1



Source: Pullam et al., 2023

Figure 2.2

Flow Diagram of Search 2



Source: Page et al. (2021).

Reporting quality screening was completed using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) combined checklist and guidelines on articles identified for the first systematic review that was published (Pullam et al., 2023; von Elm et al., 2008). Articles were scored based on total STROBE criteria with a possible range from 0 to 34 points (Pullam et al., 2023). If a criterion was judged to be present within the article, a point was awarded for the criterion; if a criterion was judged to be missing, no point was awarded. Two authors individually scored each article. A third author scored articles if any discrepancy in scoring occurred. Prior to scoring articles, it was determined that a score of 16 or less (meeting <50% of criteria) would be considered a low-quality reporting article, a score of 16 to 25 (meeting 50%-75% of criteria) would be considered a medium quality reporting article, and a score of 26 and higher (meeting 76%-100% of criteria) would be considered a high-quality article.

Literature Search Results

Dates

The combined review of literature includes all 29 articles published between 1999 and 2024. One of these 29 articles was published in 1999 (3%) (Tissot et al., 1999), eight (28%) articles were published between 2000 and 2009 (Barker et al., 2002; Bohomol et al., 2009; Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; FitzHenry et al., 2007; Hicks et al., 2004; Lisby, 2005), twelve (41%) were published between 2010 and 2019 (Bagheri-Nesami et al., 2015; Berdot et al., 2012; Ernawati et al., 2014; Feleke et al., 2015; Hernandez et al., 2015; Morelock & Kirk, 2019; Noguchi et al., 2016; Poon et al., 2010; Ramya & Vineetha, 2014; Taufiq, 2015; Welton et al., 2018; Westbrook, 2010), and eight (28%) were published in 2020 or after (Assunção-Costa et al., 2022; Furnish et al., 2021; Loput et al., 2022; Mohammed

et al., 2022; Tabatabaee et al., 2022; Tolley et al., 2022; Tsegaye et al., 2020; Wondmieneh et al., 2020).

Countries

Nine (31%) of the articles were from the United States (Barker et al., 2002; Calabrese et al., 2001; FitzHenry et al., 2007; Furnish et al., 2021; Hicks et al., 2004; Loput, 2022; Morelock & Kirk, 2019; Poon et al., 2010; Welton et al., 2018), four (14%) from Ethiopia (Feleke et al., 2015; Mohammed et al., 2022; Tsegaye et al., 2020; Wondmieneh et al., 2020) three (10%) from France (Berdot et al., 2012; Hernandez et al., 2015; Tissot et al., 1999), 2 (7%) from Malaysia (Chua, Chua et al., 2009; Chua, Tea et al., 2009), 2 (%) from Brazil (Assunção-Costa et al., 2022; Bohomol et al., 2009), two (7%) from Iran (Bagheri-Nesami et al., 2015; Tabatabaee et al., 2022), with one (3%) each from Pakistan (Taufiq, 2015), Japan (Noguchi et al., 2016), India (Ramya & Vineetha, 2014), Australia (Westbrook, 2010), Indonesia (Ernawati et al., 2014), Denmark (Lisby, 2005), and the United Kingdom (Tolley et al., 2022).

Designs

The 29 quantitative studies varied in design. Six (21%) studies were descriptive (Bagheri-Nesami et al., 2015; Calabrese et al., 2001; Chua, Chua et al., 2009; FitzHenry et al., 2008; Taufiq, 2015; Westbrook, 2010); six (21%) studies were cross-sectional (Feleke et al., 2015; Lisby, 2005; Mohammed et al., 2022; Tabatabaee et al., 2022; Tsegaye et al., 2020; Wondmieneh et al., 2020); five (17%) were prospective (Barker et al., 2002; Chua, Tea et al., 2009; Ernawati et al., 2014; Noguchi et al., 2016; Tissot et al., 1999); four (14%) were retrospective (Furnish et al., 2021; Loput et al., 2022; Morelock & Kirk, 2019; Welton et al., 2018), two (7%) were descriptive/exploratory (Berdot et al., 2012; Ramya & Vineetha, 2014); two were (7%) quasi experimental (Hernandez et al., 2015; Poon et al., 2010); one (3%) was

exploratory (Bohomol et al., 2009); one (3%) was a before and after feasibility study (Tolley et al., 2022); and one (3%) was a simple data summary (Hicks et al., 2004).

Use of Theory

All studies were reviewed for the use of theory. None of the studies in this review utilized a guiding theory.

Samples

The samples in the included studies consisted of nurses, patients, patient records, medication orders, medication administrations, medication doses, medication errors, and medication error records. Of the 29 studies, seven (24%) samples consisted of medication administration (Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Furnish et al., 2021; Loput et al., 2022; Poon et al., 2010; Tolley et al., 2022). Four (14%) studies included samples consisting of medication doses (Assunção-Costa et al., 2022; Bagheri-Nesami et al., 2015; Barker et al., 2002; Taufiq et al., 2015). The samples of three (10%) studies consisted of nurses (Mohammed et al., 2022; Ramya & Vineetha, 2013; Tsegaye et al., 2020). Two (7%) studies included samples of patients (Bohomol et al., 2009; Noguchi et al., 2016). Two (7%) studies included a sample of patient records (FitzHenry et al., 2007; Hernandez et al., 2015). One (3%) study included a sample of medication error records (Hicks et al., 2004). One (3%) study included a sample of medication events (Morelock & Kirk, 2019). Nine (31%) articles include two or more sample types (Berdot et al., 2012; Ernawati et al.; 2014; Feleke et al., 2015; Lisby et al., 2005; Tabatabaee et al., 2022; Tissot et al., 1999; Welton et al., 2018; Westbrook et al., 2010; Wondmieneh et al., 2020).

Demographics

The articles varied in the amount and type of demographics reported for the studies. Nine articles (31%) reported patient sex ranging from 44.2% to 64.6% male (Bagheri-Nesami et al., 2015; Ernawati et al., 2014; Feleke et al., 2015; Hernandez et al., 2015; Lisby, 2005; Loput et al., 2022; Noguchi et al., 2016; Poon et al., 2010; Welton et al., 2018). Nine articles (31%) reported patient ages ranging from 39 to 72.6 years (Bagheri-Nesami et al., 2015; Ernawati et al., 2014; FitzHenry et al., 2008; Hernandez et al., 2015; Lisby, 2005; Loput et al., 2022; Poon et al., 2010; Welton et al., 2018; Westbrook, 2010). One article (3%) provided the percentage of patients older than 65 years (62%) but provided no mean age (Noguchi et al., 2016). Two (7%) articles provided information on race and ethnicity, with White (40.6%-65.5%), African American/Black (14%-16.4%), and Hispanic/Latino (42.1%) reported as the most common reported races and ethnicities (Loput et al., 2022; Welton et al., 2018). Eight (28%) articles reported nurses' sex, with a range of 0% to 45.7% male (Bagheri-Nesami et al., 2015; Berdot et al., 2012; Feleke et al., 2015; Mohammed et al., 2022; Ramya & Vineetha, 2014; Tabatabaee et al., 2022; Tsegaye et al., 2020; Wondmienen et al., 2020). Nursing mean age was reported by four (14%) articles, with a range of 29 to 33.96 years (Feleke et al., 2015; Tabatabaee et al., 2022; Tsegaye et al., 2020; Wondmienen et al., 2020). One (3%) article did not provide nurses' mean age but did provide the percentages of nurses within age ranges; the largest percentage of nurses (47.8%) fell within the 25-29 age range (Mohammed et al., 2022). Twelve (41%) articles provided no demographic information on their samples (Assunção-Costa et al., 2022; Barker et al., 2002; Bohamol et al., 2009; Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Furnish et al., 2021; Hicks et al., 2004; Morelock & Kirk, 2019; Ramya & Vineetha, 2013; Taufiq et al., 2015; Tissot et al., 1999).

Definitions

Table 2.1 presents medication administration timing error definitions. The most common definition among studies was administration more than 60 minutes before or after a scheduled dose given in 15 (52%) studies (Assunção Costa et al., 2022; Barker et al., 2002; Berdot et al., 2012; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Calabrese et al., 2001; Ernawati et al., 2014; FitzHenry et al., 2008; Hernandez et al., 2015; Poon et al., 2010; Ramya & Vineetha, 2014; Tissot et al., 1999; Tolley et al., 2022; Welton et al., 2018; Westbrook, 2010; Wondmieneh et al., 2020). Among those 15 studies, three (10%) also included an additional definition of medication administration timing error of more than 30 minutes before or after scheduled time if the medication timing was related to a meal (Assunção Costa et al., 2022; Barker et al., 2002; Westbrook, 2010). One (3%) article defined medication administration timing error as medications administered more than 60 minutes before or after the schedule for time-critical medications and more than 120 minutes before or after the scheduled time for non-time-critical medications (Furnish et al., 2021). Two (7%) studies defined medication administration timing error as the administration of medications more than 30 minutes before or after the scheduled time (Feleke et al., 2015; Mohammed et al., 2022). One (3%) article defined medication administration timing error as the administration of medications 15 minutes before or after the scheduled time if ordered every 4, 6, 8, or 12 hours or more than 30 minutes before or after the scheduled time if ordered daily (Bohomol et al., 2009). One (3%) article defined medication administration timing error as a medication not administered at the scheduled time (Tsegaye et al., 2020). One (3%) article did not define medication administration timing error but provided measurement parameters used within the studies of 30-59 minutes, 60-120 minutes, and >120 minutes (Loput et al., 2022). Eight (28%) articles did not include a clear definition of medication

administration timing error (Bagheri-Nesami et al., 2015; Ernawati et al., 2014; Hicks et al., 2004; Lisby, 2005; Morelock & Kirk, 2019; Noguchi et al., 2016; Tabatabaee et al., 2022; Taufiq, 2015).

Procedures

Procedures used in the studies included observation, data abstraction, and self-report. Twelve (41%) studies conducted direct observation for data collection (Assunção-Costa et al., 2022; Barker et al., 2002; Berdot et al., 2012; Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Ernawati et al., 2014; Feleke et al., 2015; Hernandez et al., 2015; Poon et al., 2010; Tissot et al., 1999; Westbrook, 2010). Nine (31%) studies completed data extraction from medical records, clinical data warehouses, or incident report systems (FitzHenry et al., 2008; Furnish et al.; 2021; Hicks et al., 2004; Morelock & Kirk, 2019; Noguchi et al., 2016; Loput et al., 2022; Tabatabaee et al., 2022; Taufiq, 2015; Welton et al., 2018). Self-report was utilized by four (14%) studies (Bagheri-Nesami et al., 2015; Bohomol et al., 2009; Mohammed et al., 2022; Ramya & Vineetha, 2014). Four (14%) studies used two techniques: observation plus an additional technique of self-report or medical record review (Lisby, 2005; Tolley et al., 2022; Tsegaye et al., 2020; Wondmieneh et al., 2020).

Measures

Medication administration timing error frequency was calculated in multiple ways throughout the studies. Twelve (41%) studies calculated medication administration frequency as the percentage of occurrences out of total medication doses or administrations using a numerator of medication administration errors and a denominator of all scheduled medication doses or administrations (Assunção-Costa et al., 2022; Barker et al., 2002; Feleke et al., 2015; Furnish et

Table 2.1*Included Articles' Definitions of Medication Administration Timing Error (MATE) (N=29)*

Author/Year	Definition of MATE
Assunção-Costa et al. (2022)	>60 minutes before/after scheduled time or 30 minutes before after dosing with/before/after meal
Bagheri-Nesami et al. (2015)	Unclear
Barker et al. (2002)	>60 minutes before/after schedule or 30 minutes before after dosing with meal
Berdot et al. (2012)	>60 min before/after schedule
Bohomol et al. (2009)	>15 min after scheduled time if scheduled every 4, 6, 8 or 12 hours, or >30 minutes for daily doses
Calabrese et al. (2001)	>60 min before/after schedule
Chua, Chua et al. (2009)	>60 min before/after schedule
Chua, Tea et al. (2009)	>60 minutes before/after schedule
Ernawati et al. (2014)	Unclear
Feleke et al. (2015)	>30 min before/after schedule
FitzHenry et al. (2007)	>60 min before/after schedule
Furnish et al. (2021)	>60 minutes before/after schedule for time-critical medications and >120 minutes before/after schedule for non-time-critical medications
Hernandez et al. (2015)	>60 minutes before/after schedule
Hicks et al. (2004)	Not defined – Reported from facilities
Lisby et al. (2005)	Unclear – utilized guideline
Loput et al. (2022)	No definition was provided, however measurement parameters for data collection provided of 30-59 minutes, 60-120 minutes, and >120 minutes
Mohammed et al. (2022)	>30 min before/after schedule
Morelock & Kirk (2019)	Unclear
Noguchi et al. (2016)	Unclear
Poon et al. (2010)	60 minutes before/after schedule
Ramya & Vineetha (2014)	>60 min before/after schedule
Tabatabaee et al. (2022)	Unclear
Taufiq et al. (2015)	Unclear
Tissot et al. (1999)	>60 min before/after schedule
Tolley et al. (2022)	>60 min before/after schedule
Tsegaye et al. (2020)	Defined as not administered at scheduled time
Welton et al. (2018)	>60 minutes before/after schedule
Westbrook et al. (2010)	>60 min before/after schedule, or >30 minutes before/after if scheduled with meal
Wondmieneh et al. (2020)	>60 min before/after schedule

al., 2021; Hernandez et al., 2015; Loput et al., 2022; Taufiq, 2015; Tissot et al., 1999; Tolley et al., 2022; Welton et al., 2018; Westbrook, 2010; Wondmieneh et al., 2020). One (3%) study calculated the frequency as the percentage of orders using a numerator of medication administration timing error and denominator of orders and also as a percentage of doses using a numerator of medication administration timing errors and a denominator of all scheduled doses (FitzHenry et al., 2008). Eight (28%) studies calculated the frequency as a percentage of administration errors that occurred using a numerator of all medication administration timing errors and a denominator of all measured administration errors (Berdot et al., 2012; Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Lisby, 2005; Ernawati et al., 2014; Morelock & Kirk, 2019; Poon et al., 2010). Six (21%) studies calculated the frequency as the percentage of all errors that occur throughout the medication process using a numerator of medication administration timing errors and a denominator of all errors that occurred throughout the medication process including orders and administrations (Bagheri-Nesami et al., 2015; Bohomol et al., 2009; Hicks et al., 2004; Noguchi et al., 2016; Ramya & Vineetha, 2014; Tabatabaee et al., 2022). Lastly, two (7%) studies calculated the frequency as the number of nurses who reported being involved in a medication administration timing error, with a numerator of all nurses reporting involvement in a medication administration timing error and a denominator of all nurses surveyed (Mohammed et al., 2022; Tsegaye et al., 2020).

Frequency

The reported frequency of medication administration timing error varied between studies. The lowest medication administration timing error rate reported in the 29 articles was 0.7%, calculated pre-implementation computerized physician order entry system, during a quasi-experimental study using observational procedures measuring the frequency as the percentage of

medication administrations (Hernandez et al., 2015). The highest rate of medication administration timing error reported was 72.6%, in a descriptive/exploratory study using observational procedures, measuring the frequency as the percentage of all errors that occurred (Berdot et al., 2012). Seven (24%) articles identified medication administration timing error as the most common medication error (Barker et al., 2002; Berdot et al., 2012; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Mohammed et al., 2022; Tsegaye et al., 2020; Westbrook, 2010).

The medication administration timing error rates were compared among studies with similarities in design. Eight (28%) studies shared a standard definition of medication administration timing error of medications administered more than 60 minutes before or after the scheduled time as well as calculation of the error as the percentage of medication administrations or doses (Assunção-Costa et al., 2022; Barker et al., 2002; Hernandez et al., 2015; Tissot et al., 1999; Tolley et al., 2022; Welton et al., 2018; Westbrook et al., 2010; Wondmieneh et al., 2020). The medication administration timing error rate among these studies ranged from 0.7% to 67.4%. Among these studies, five (17%) studies utilized observation procedures to collect data and reported an error rate ranging from 0.7%-16.1% (Assunção-Costa et al., 2022; Barker et al., 2002; Hernandez et al., 2015; Tissot et al., 1999; Westbrook et al., 2010). Five (17%) studies defined medication administration timing error as medications administered more than 60 minutes before or after the scheduled time and calculated the error rate as the percentage of administration errors. Among these studies, the frequency reported ranged from 13.9% to 72.6% (Berdot et al., 2012; Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Poon et al., 2010). The procedure used to collect data from all five studies was observation.

Quality

Quality scoring using STROBE criteria was completed on each of the 23 articles included in the published manuscript (Pullam et al., 2023; von Elm et al., 2008). The reviewers obtained a mean quality score of 22.09, a median score of 23, and a range of 15 to 27. The reviewers identified four (17%) high-quality articles (Feleke et al., 2015; Hernandez et al., 2015; Tsegaye et al., 2020; Westbrook, 2010), 18 (78%) moderate quality articles (Bagheri-Nesami et al., 2015; Barker et al., 2002; Berdot et al., 2012; Bohomol et al., 2009; Calabrese et al., 2001; Chua, Chua et al., 2009; Chua, Tea et al., 2009; Ernawati et al., 2014; FitzHenry et al., 2008; Hicks et al., 2004; Lisby, 2005; Morelock & Kirk, 2019; Noguchi et al., 2016; Poon et al., 2010; Ramya & Vineetha, 2014; Tissot et al., 1999; Welton et al., 2018; Wondmieneh et al., 2020), and one (4%) low-quality article (Taufiq, 2015). Quality scoring was not completed on the articles obtained through the searches completed March 2021-May 2024.

Measurement of Time-critical Medication Administration Timing Error Rate

Three studies provided error rates for high-alert or time-critical medications (Furnish et al., 2021; Loput et al., 2022; Welton et al., 2018). High-alert medications are more likely to result in harm than standard medications if given in error (Institute for Safe Medication Practices, 2018). High-alert medications generally require administration within 30 minutes of the scheduled time. Welton et al. (2018) measured the rate of wrong-time administration for specific high-alert medications. High-alert medications were given outside of the 30-minute timeframe between 19.2% and 32.7% while the overall rate of error, measured using a 60-minute window, was 12.1%. When measuring high-alert medications with the more lenient 60-minute window, the rate of medications administered at the wrong time dropped significantly to 9.4-12.9% suggesting that the narrow timeframe for administration required for high-alert

medications results in increased error rates despite elevated risks to patients. The authors did not further explore differential factors between the two types of medications. Loput et al. (2022) measured delays for specific high-risk therapeutic drug categories and identified that 15% of medications were given more than 60 minutes after scheduled. The authors did not measure the rate of standard or overall medication administration timing error. Furnish et al. (2021) measured on-time administrations for both time-critical and non-time-critical medications administration to determine if a significant difference between the two medication types existed. Time-critical medications were administered on time only 69% of the time compared to non-time-critical medications at 84%. The difference was found to be statistically significant. None of the studies explored relationships to shared causative factors between standard and time-critical or high-alert medication administration timing error.

Causes

Causative factors that were potentially related to medication administration timing error were explored within two (7%) articles. Taufiq et al. (2015) identified factors for both early and late medication administration. Factors for early medication errors included patient condition, patient wanting to sleep early, system-related causes, pre-meal requirements, planned procedures, or doctor orders. The majority of early medication administration records provided no or unclear causative factors. The identified factors related to late medications most frequently were receiving medications late from the pharmacy, workload issues, forgetting to document, errors in documentation, patients sleeping, patients refusing medication at scheduled times, patients gone at scheduled times, system-related issues, multiple intravenous medications, or technical issues. The majority of late medication administration records provided no causative factors. Assunção-Costa et al. (2022) identified interruptions as the main associated factor to

medication administration timing error, noting that nurses are two times more likely to commit an error if interruptions occur at any time in the medication process. While Loput et al. (2022) did not specifically identify causative factors for medication timing errors, it should be noted that there was a significance in delays of medications in the hours of 9 a.m.–10 a.m. and 9 p.m.–10 p.m., as 44.9% of administration delays (275,257) of 60 or more minutes occurred during these hours.

Though interventional studies did not specifically address the correlating factors, there was a noted effect on the rate of medication administration timing error rate due to the intervention in the two (7%) quasi-experimental articles (Hernandez et al., 2015; Poon et al., 2010). Hernandez et al. (2015) measured error rates before and after implementing a computerized provider order entry (CPOE) system and identified a 65% increase in medication administration timing errors. In contrast, Poon et al. (2010) measured medication error rates before and after implementation of a bar-code scanning administration system and identified a decrease of 4.5% after implementation.

Consequences

Only three (10%) articles investigated consequences or potential consequences specifically for medication administration timing error. Hicks et al. (2004) identified that patient harm resulted from 1% of medication administration timing error. Tissot et al. (1999) deemed that 55.6% of wrong-time errors were potentially clinically significant. Barker et al. (2002) found that 15% of medication administration timing errors that occurred had the potential to be clinically significant.

Discussion

There was a great deal of heterogeneity among the studies included in this literature review. This diversity was apparent in the designs, definitions, samples, procedures, and measures. There were also widely varying reported frequencies of medication administration timing error. Additionally, very few studies that measured medication administration timing error also included data on the causes or consequences of these errors.

The definition of medication administration timing error was inconsistent among the studies in this literature review. However, more than 50% of studies did identify the most common definition of medication administration timing error being *medications administered more than 60 minutes before or after the scheduled time*. This definition, however, was one of several definitions used, including 15 minutes, 30 minutes, and even 120 minutes before or after a medication's scheduled time. Most alarmingly, in eight (28%) of the studies, a clear definition was not provided within the reporting articles. Ambiguous definitions may lead to incorrect assumptions or missed information creating uncertainty in reporting and hindering the ability to evaluate the body of research (Needleman et al., 2008). The lack of consistency of a definition highlights the continued lack of understanding of the extent of medication administration timing error.

Using a trusted organization's standard guideline for the definition of medication administration timing error is recommended (Pullam et al., 2023). The Institute for Safe Medication Practices published Acute Care Guidelines for Timely Administration of Scheduled Medications, which guides the administration of scheduled medications in acute care (Institute for Safe Medication Practices, 2011). This provides researchers with a definition of timely

medication administration in acute care for time-critical and non-time-critical medications, which encourages standardization.

The most common designs were descriptive and cross-sectional, accounting for 41% of the overall designs. The cross-sectional design is a design that allows for the collection of multiple data at once in order to estimate the prevalence of an outcome in an environment as well as the possibility of further studying the association between exposures and outcomes (Setia, 2016). A descriptive study, on the other hand, describes the distribution, such as the frequency, of one or more variables and may include cross-sectional studies but does not include any analysis of causation or hypotheses (Aggarwal & Ranganathan, 2019).

The settings of all studies included in this review were acute care units in 12 countries. The majority of studies (n=9, 31%) were from the United States. Other countries included Ethiopia, France, Malaysia, Brazil, Iran, Pakistan, Japan, India, Australia, and the United Kingdom.

The samples were inconsistent among the studies as well. The most common sample utilized in the studies was medication administrations which was utilized in 24% of the studies. Other samples included medication orders, patients, nurses, or a combination of two or more samples. Representative samples that meet the objectives of the research studies are necessary to generalize quantitative findings among a larger population, and variation and potential flaws in design inhibit comprehensive interpretation of the results (Garg et al., 2008; Khalid et al., 2012). This lack of consistency in the research may lead to unaccounted-for variation and a lack of representative samples in the body of evidence. A lack of a representative sample in scientific evidence can decrease the external validation (Carlson & Morrison, 2009). An ideal sample for measuring medication administration timing error would capture the total opportunities for errors

to occur through either medication administrations, doses, or orders, providing consistency across studies.

The measures used to calculate the frequency of medication administration error were inconsistent among the studies. The resulting rate was reported as a percentage of medication administrations, percentage of orders, percentage of administration errors, percentage of medication errors, or a percentage of nurses involved in errors. The numerator for all calculations was the number of medication administration timing errors that were identified. The denominator, however, varied and included doses or administrations, orders, administration errors, all medication errors, or all nurses. The most frequent (41%) measure for calculation was the percentage of medication administration; however, more than half of the studies calculated medication administration timing error as a percentage of medication administration errors or total medication errors, which does not provide a complete picture of the error.

The procedures to collect data on medication administration timing error varied among the studies and included observation, data abstraction, self-report, or a combination of techniques. Observation was the most frequent procedure completed (41% alone; 14% with an additional technique), offers good-quality data about administration errors, and provides the most accurate technique to capture active errors (Montesi & Lechi, 2009). While this technique is the gold standard for collecting error data, it often is more time-consuming and requires more training than alternate techniques.

The reported frequency of medication administration timing error varied widely among the studies in this review of literature due to inconsistencies in design, definitions, samples, procedures, and measurement procedures. Medication administration timing error was reported as the most common error in seven (24%) studies. The rate ranged from 0.7% to 72.6%. When

comparing the five (17%) studies that shared the most common definition (more than 60 minutes before or after scheduled dosage), the most common data collection procedure (observation), and the most common calculation method (percentage of medication administrations or doses) there was a less drastic but still varied range of reported frequency of medication administering timing error rates from 0.7% to 16.1% (Assunção-Costa et al., 2022; Barker et al., 2002; Hernandez et al., 2015; Tissot et al., 1999; Westbrook et al., 2010).

Only three studies measured medication administration timing in time-critical or high-alert measurement. High-alert medications were administered more than 60 minutes after scheduled 15% of the time despite the increased risk of harm when these medications are administered in error (Loput et al., 2022). High-alert and time-critical medications were more likely to be administered outside of their 30-minute timeframe compared to standard medications (Furnish et al., 2021; Welton et al., 2018). Additionally, the lower rate of on-time administration for time-critical medication was statistically significant.

Few studies addressed causative factors of medication administration timing error. Taufiq et al. (2015) identified multiple factors associated with early and late medication administration timing error. Early medication administration factors included patient condition needs, patient requests for time change, and early administration due to meal requirements. Factors reported in late administrations included receiving meds late from pharmacy, increased workload demands, errors in documentations, patient sleeping, patient refusal, patient absence, technical issues, or system issues such as late arrival of meal trays for meds required to be given with meals. Assunção Costa et al. (2022) identified interruptions as the most common factor associated with medication administration timing error. Loput et al. (2022) identified significant medication administration delays between 9 a.m.–10 a.m. and 9 p.m.–10 p.m. Two interventional

studies also identified changes to medication administration timing error after implementation. There was a 65% increase in administration timing error after the intervention implementation of a computerized provider order entry system (Hernandez et al., 2015). Alternatively, there was a 4.5% decrease in medication administration timing error after implementation of a bar-code scanning administration system (Poon et al., 2010). The findings suggest that multiple factors are associated with medication timing error and system changes may cause varying effects on medication administration timing.

Consequences of medication administration timing errors were identified in only three of the included studies. When measured, 1% of medication timing errors resulted in patient harm (Hicks et al., 2004). Potential clinically significant consequences were measured in two studies ranging from 15-55.6% for wrong time errors (Barker et al., 2002; Tissot et al., 1999). While most studies did not evaluate the consequences of medication administration timing error, harm or other adverse clinical consequences were identified in those that did. The designs of research studies on medication timing error in acute care remain in the descriptive stage. Unfortunately, the heterogeneity in research design plaguing the available studies inhibits the ability to comprehend the extent of the issue. While several studies are available, the lack of cohesiveness prohibits moving to the next stage in research, as better understanding of medication timing error must still be sought.

There is an opportunity to improve the evidence on the prevalence of medication administration timing error in acute care and the associated factors through future research. There are many gaps surrounding medication administration timing error and its reporting in acute care, but the most pressing are the lack of clarity surrounding the extent of this issue and

the influencing factors. Future research can provide a better understanding and provide the foundational knowledge that is needed to narrow the gap that currently exists.

Limitations and Strengths

This review has several limitations. Exclusion of non-English articles due to the author's language limitations may have introduced bias. The exclusion of non-English speaking research reduces generalizability of results and may introduce bias result estimations due to English language publication differences (Valdez & Goodson, 2020) Additionally, only those studies that included a rate of medication administration timing error were included, so articles that may have included causes or consequences without frequency may have been overlooked. Finally, this review of literature did not include gray literature. Gray literature, or unpublished research, includes things such as academic papers and dissertations (Paez, 2017). Gray literature is less likely than published literature to identify statistically significant findings but is as likely to follow robust methodological approaches (Conn et al., 2003). The inclusion of gray literature in systematic reviews may provide additional evidence not available in commercial publications and reduce publication bias in systematic reviews (Paez, 2017).

A strength of this review is that it included two exhaustive literature searches, including articles from 1999 to 2024. The exhaustive nature of this search is demonstrated by use of clear inclusion and exclusion criteria and robust search strategies as well as the use of three reputable search databases.

Conclusion

Though several studies provide a rate of medication administration timing error in acute care since 1999, the research remains in the descriptive state. Substantial methodological heterogeneity between the studies complicates accurate synthesis and understanding. The

scientific evidence on medication administration timing error is plagued by the use of multiple definitions. There was inconsistency in designs. Samples varied between studies. Data collection procedures and calculation methods differed between studies, as well. The medication administration timing error rate that was reported varied significantly throughout the scientific literature. Few studies measured time-critical or high-alert medication administration timing error. Additionally, few studies discuss causative factors or consequences associated with medication administration timing error, providing further evidence the knowledge gap surrounding the error. Despite emphasizing patient safety, medication administration timing error remains a common issue in acute care, and further exploration on its impact in acute care is needed. It is essential to improve the rigor of the literature on medication administration timing error and thoroughly explore the extent of the issue.

This chapter summarized the state of the literature surrounding the frequency of medication administration timing error, its causative factors, and its consequences in acute care. It provided a discussion of the methods, literature search results, and a discussion of the systemic review findings.

CHAPTER 3

METHODOLOGY

This chapter describes the design and methodology of the study. A descriptive, correlational design, utilizing an online survey, was chosen for this study. This chapter includes details of the design, setting, sample, measures, procedures, and data analysis techniques that were utilized for this study.

Design

The study used a descriptive, correlational design to investigate the prevalence of medication administration timing error, the prevalence of medication administration timing error reporting, and the correlation with patient safety culture. High reliability organization (HRO) theory guided the development of this study. There were three variables of interest for this study. The first variable was patient safety culture, as measured by the mean composite scores on the Hospital Survey of Patient Safety Culture Version 2.0 (HSOPS 2.0) (Sorra et al., 2019). The second variable was medication administration timing error as measured by the self-reported frequency of on-time medication administration. The final variable was underreporting of medication administration timing error reporting as measured by the self-reported frequency of reporting medication administration timing error.

Medication administration timing error and medication administration timing error reporting were measured using questions created by the primary investigator (PI). Nurses reported the prevalence on a unit level as well as an individual level and for time-critical and non-time-critical medications.

Setting

This study was conducted using the online platform of Research Electronic Data Capture (REDCap) hosted at the University of Missouri-Kansas City (Harris et al., 2009). A survey was chosen for this study because it allowed for a large sample to be addressed while exploring a broad range of information (Roberts, 2014). Utilizing an online survey for this study provided the opportunity to gather representative data from a large population simultaneously.

Sample

The target population of the study was the acute care registered nursing workforce within the United States. The United States registered nurse demographic breakdown includes 80% white, 10.2% black, 7.4% Asian, 0.4% American Indian or Alaskan Native, 2.5% multiple races, and 3.4% identified as other (Smiley et al., 2023). Additionally, 6.9% of this population identifies as Hispanic or Latino ethnicity. The gender breakdown of registered nurses in the United States shows males making up 11.2% of the population, females making 88.5%, and 0.4% identifying as other.

The United States has an approximate population of 4,306,972 registered nurses (Smiley et al., 2023). The nine states of Alaska, Arizona, Arkansas, California, Iowa, Kansas, Nebraska, New Jersey, and Vermont provide an accessible population of 935,404 registered nurses. The combination of random sampling within diverse areas of the country was chosen to allow for a more generalizable sample.

Inclusion Criteria

Participants had to meet the following inclusion criteria: a) have the ability to read English, which was determined by the ability to follow the instructions written in English to open and complete the study survey; b) have worked in the current acute care unit for at least 30 days;

c) have administered medications during the last 30 days on assigned work unit; and d) work on the assigned unit an average of 24 or more hours weekly. Appendix C describes the questions used to screen for inclusion or exclusion.

Exclusion Criteria

The following criteria for exclusion were utilized: a) the participant is unaware of the policy for timing of time-critical (time-sensitive) medications and/or non-time-critical (non-time-sensitive) medications on the current work unit or b) the participant's current work unit does not have a current policy for timing of time-critical (time-sensitive) medications and/or non-time-critical (non-time-sensitive).

Calculation of Sample Size

To determine a target sample size, a priori power analysis was completed using the G*Power software application (Faul et al., 2007). The power analysis utilized an exact test family and correlation: bivariate normal mode statistical test. A two-tailed test was chosen to identify both positive and negative correlations. The analysis was run using a moderate effect size of 0.3, a significance of 0.05, and a power of 0.8, resulting in a sample size target of 84. A sample size minimum of 84 participants with completed surveys was the target for this study.

Measures

The online survey included sections for assessing participant demographics, unit timing policy, the prevalence of medication administration timing error, the prevalence of medication administration timing error reporting, and patient safety culture. Details of those survey sections follow.

Demographics

Questions assessing demographic information were included in the online survey (see Appendix D). Demographic data included 1) gender, 2) age, 3) race, 4) ethnicity, 5) highest level of education completed, 6) length of nursing experience, 7) type of nursing unit, 8) time on current unit, and 9) position on unit.

Unit Policy

Next, two questions were included to establish the policy at the nurse's work unit. These questions asked participants to identify their unit's medication timing policy for both time-critical and non-time-critical medications. Those questions can be found in Appendix E.

Prevalence of Medication Administration Timing Error

The prevalence of medication administration timing error was measured utilizing four questions (see Appendix F). Using a 5-point Likert scale ranging from "always" to "never," two questions measured unit prevalence. The PI created questions modeled after MISSCARE survey question that identified missed nursing care related to administering medications on time (Kalisch & Williams, 2009). The MISSCARE survey question identified self-reported estimates on nursing units for medications given outside a 30-minute scheduled timeframe and provided psychometric measurements of reliability and validity. These measurements included a Cronbach alpha value range of 0.64 to 0.86, demonstrating internal consistency and reliability, and confirmatory factor analysis demonstrating a good fit of the data for validity. Additionally, the MISSCARE survey showed reliability on the test-retest of the same subjects with a Pearson correlation coefficient value of 0.87. The questions included in this survey were modified to be positively worded and to simplify the language. The questions were also modified to ask about both time-critical and non-time-critical medication in order to reflect the current CMS rules that

each facility must have a policy differentiating between time-critical and non-time-critical medications and a timing rule consistent with that policy (State Operations Manual – CMS, 2020). Two questions, using a 4-point ordinal scale of percentile ranges (0-25%, 26-50%, 51-75%, and 76-100%), were used to identify the percentile range of medications administered on time. The rate of medication administration timing error was found by subtracting the percentile range of on-time administration from 100%. For example, if participants responded that they administer medications on time 0-25% of the time, then 75-100% of their medications would be considered a medication administration timing error.

Prevalence of Unreported Medication Administration Timing Error

Questions used to measure the prevalence of medication administration timing error underreporting can be found in Appendix G. Two questions, both using a 5-point Likert scale, measured the prevalence of unreported medication administration timing error. The questions asked respondents to identify how often medication administration timing errors that occur on the unit where the nurse worked are reported with responses ranging from “always” to “never.” These questions were formatted to reflect similar positive and simplified language of the previous questions. Two positively-worded questions, using a 4-point ordinal scale of percentile ranges (0-25%, 26-50%, 51-75%, and 76-100%), were utilized to estimate the individual prevalence of reporting medication administration timing error and utilize a percentile range. The percentage of underreporting of medication administration timing error was identified by subtracting the percentile range of timing errors reported by 100%. For example, if respondent indicated they report 0-25% of their medication administration timing error, then 75-100% of their medication administration timing errors were unreported.

Patient Safety Culture

Patient safety culture was measured utilizing sections A through F of the Hospital Survey of Patient Safety Culture Version 2.0 (HSOPS 2.0) (see Appendix H) (Sorra et al., 2019). The *AHRQ Hospital Survey on Patient Safety Culture Version 2.0: User's Guide* recommends that the tool not be modified beyond the demographic questions to ensure consistent validity and reliability (Sorra et al., 2019). Because of this recommendation, the tool was not modified. In a study comparing current and previous versions of the HSOPS 2.0, response rates were approximately 44% in 2017 and 39% in 2019 among all groups (Sorra, n.d.). Safety culture was identified utilizing the ten composite measures of the following patient safety culture dimensions: teamwork, staffing and work pace, organizational learning/continuous improvement, response to error, leadership, communication, communication openness, reporting, hospital management support for patient safety, and handoffs/information exchange. Two additional single-item questions, number of events reported and patient safety rating, were also included in the survey (Sorra et al., 2019).

Each composite measure consisted of 2-4 questions that measured characteristics of the patient safety culture dimensions (see Appendix I). Each question consisted of choices on a Likert scale from 1-5 ranging from “strongly disagree” to “strongly agree” and an additional choice of “does not apply/don't know.” Positively worded and negatively worded questions were included in the survey (SOPSTM Hospital Survey Items and Composite Measures, n.d.).

The HSOPS 2.0 is a valid and reliable instrument explicitly created to measure patient safety culture in the hospital setting. Psychometric testing was completed for the HSOPS 2.0 during a 2019 pilot test that surveyed all providers and staff in 25 hospitals (Sorra, n.d.). Each participant was randomly assigned to one of three groups: a group taking a previous version of

the survey, a group taking the previous version of the survey with an addition of the “does not apply/ don’t know” option on questions, and a group taking the HSOPS 2.0.

All composite measures of HSOPS 2.0 except for Staffing and Work Pace had a Cronbach’s alpha of greater than 0.70, demonstrating acceptable internal consistency reliability (Sorra, n.d.). Staffing and Work Pace had a Cronbach’s alpha of 0.67. All composite measures and items had acceptable site-level reliability of more than 0.70. Confirmatory factor analysis was also completed, and all items had acceptable factor loadings on their composite measures equal to or greater than 0.40. Additionally, several goodness-of-fit indices (comparative fit index, root mean square of approximation, and standardized root mean square residual) were completed and demonstrated acceptable overall model fit.

Procedures

Pretesting

Survey pretesting was completed to provide an opportunity to improve the instrument before it was used for data collection (Blair et al., 2014). This process was completed prior to submitting the study to the Institutional Review Board at the University of Missouri-Kansas City.

Initially, a target sample size of 30 registered nurses was selected based on previous literature recommending sample sizes for pretesting between 12 and 40 participants (Blair et al., 2014; Perneger et al., 2015; Ruel et al., 2016). Perneger et al. (2015) calculated that a sample size of 30 participants would be sufficient to detect problems affecting 5% of the total study population.

Registered nurses were recruited for pretesting the survey using snowball sampling through work associates and friends of the PI. Participants in pretesting were asked to complete the survey, noting any issues encountered, and then complete a semi-structured interview in

person, via an online conferencing tool, or by phone with the PI. The semi-structured interview questions can be found in Appendix J. The semi-structured interviews assisted the PI to obtain feedback on survey clarity, flow, technical quality, and effort (Ruel et al., 2016). The semi-structured interview provided a guide to ensure all concerns were addressed. However, it allowed the interviewer to modify or expand on questions to ensure understanding of participant feedback and ensure complete data collection.

Due to low participation, initial pretesting was completed after 12 interviews when saturation was met. Feedback on the survey was positive, with only minor changes needed to improve the clarity of the questions and answers for participants. The issues identified during pretesting were addressed, and additional survey pretesting was conducted with a sample of three registered nurses who evaluated the survey for any further issues.

Risk Reduction

Following survey pretesting, study exempt status approval (project number 2099395) was obtained by the PI from the Institutional Review Board (IRB) at the University of Missouri, Kansas City (UMKC). This study was considered exempt by the IRB because no identifiable information was collected. The PI remained responsible for all collected data. The data files are stored and will remain in the University of Missouri-Kansas City OneDrive for a minimum of seven years.

Survey Participation

The online survey took approximately 15 minutes to complete. No identifiable data were collected in the survey to ensure anonymity. Electronic consent was obtained through the completion of the survey. Included in the consent statement was an estimated time of completion, an explanation of the purpose, and the benefits and risks of the study.

Data Analysis

Data Management

Survey data were collected through Research Electronic Data Capture (REDCap) hosted at the University of Missouri-Kansas City (Harris et al., 2009). Data were secured and stored in REDCap. The data stored in REDCap were exported into Statistical Package for the Social Sciences (SPSS), version 27, for analysis by the PI (IBM Corporation, 2020). The PI examined data for missing values and outliers and cleaned data as necessary to ensure data validity before completing the analysis.

Demographic Data

Demographic data were summarized using descriptive statistics. Categorical data of gender, race, ethnicity, work unit, position, and highest level of education are presented as frequency and percentage. Ratio data of age and variable data of length of nursing experience and length at the current unit are expressed through range, mean, median, and standard deviation.

Unit Policy Data

For policy-establishing questions, the calculation was completed using descriptive analysis. The frequency of each category is expressed as a percentage. The numerator is the number of respondents choosing each category divided by the denominator, which is the total number of respondents. The number is then multiplied by 100 to provide a percentage.

Research Question One

The first research question was, “What is the unit and individual prevalence of medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units?” Descriptive statistical

analysis was completed for all included questions to evaluate medication administration timing error prevalence.

Descriptive analysis was performed for each response category (ranging from “never” to “always”) regarding the prevalence of medication administration timing errors on work units for both time-critical and non-time-critical medications. This is expressed as a percentage. The number of participants choosing each category (numerator) was divided by the total number of participants (denominator). That number was multiplied by 100 to provide a percentage.

Descriptive statistical analysis was also performed for the four response categories (ranging from 0-25% to 76-100%), identifying individual participant prevalence for both time-critical and non-time-critical medications. This was expressed as a percentage. The number of participants choosing each percentile range (numerator) was divided by the total number of participants (denominator). That number was multiplied by 100 to provide a percentage. To identify the percentage of medication administration timing error, the percentile ranges were subtracted from 100%.

Research Question Two

The second research question was, “What is the unit and individual prevalence of underreporting medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units?”

Descriptive statistical analysis was completed for all included questions to evaluate underreporting of medication administration timing error prevalence.

Descriptive analysis was performed for each response category (ranging from “never” to “always”) for the prevalence of unreported medication timing error in work units regarding reporting of missed care for time-critical and non-time-critical medications. This is expressed as

a percentage. The number of participants choosing each category (numerator) was divided by the total number of participants (denominator). That number was multiplied by 100 to provide a percentage.

Descriptive statistical analysis was performed for each response category (ranging from 0-25% to 76-100%) to determine the prevalence of unreported medication timing error identified for individual participants for both time-critical and non-time-critical medications. This is expressed as a percentage. The number of participants choosing each percentile range (numerator) was divided by the total number of participants (denominator). That number was multiplied by 100 to provide a percentage. To identify the prevalence of unreported medication administration timing error, the percentile ranges were subtracted by 100%.

Research Question Three

The third research question was, “What is the correlation of unit and individual prevalence of medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units with patient safety culture?” The four variables of interest for the prevalence of medication administration timing error included within this analysis was the ordinal variables from the Likert scale responses to questions on medications administered on time at the unit level for both time-critical and non-time-critical medications as well as the percentile ordinal responses for medications administered on time at the individual levels for both time-critical and non-time-critical. These variables were analyzed for correlation with patient safety culture utilizing the variable of interest, the mean of responses on the ten composite measures of the HSOPS 2.0 survey.

To identify mean responses for the composite measures of the HSOPS 2.0, responses for each composite measure were aggregated, and the mean score was calculated. The mean score was the unit of measure. Each composite measure consists of 2-4 questions with choices on a Likert scale of 1-5 ranging from “strongly disagree” to “strongly agree” and an additional choice of “does not apply/don’t know.” As some questions are negatively worded, those question values were reversed before aggregating the composite score answers. Any “does not apply/don’t know” answers were not included in the mean score. The average of each participant’s composite scores was calculated by adding the score for each answered question within the composite measure and dividing by the number of the answered questions in the composite measure, excluding questions that were answered with “does not apply/don’t know.” Therefore, scores can range from 1 to 5 for each mean composite measure.

Spearman Rho, also known as Spearman Rank, was used to identify this correlation between the ordinal variables. This identified the direction and strength of relationships between the variables of interest for research question three. Spearman Rho analysis is recommended for ordinal scale data (Kruskal, 2012).

Research Question Four

The fourth research question was, “What is the correlation of unit and individual prevalence of underreporting medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units with patient safety culture?” The four variables of interest for the prevalence of unreported medication administration timing error included within this analysis were the ordinal variables of the Likert scale responses for reporting of medications administered on time at the unit level for both time-critical and non-time-critical medications and the percentile ordinal responses for

reporting at the individual levels for both time-critical and non-time-critical medications. These variables were analyzed for correlation with the variables of interest for patient safety culture, which were the mean responses of all Likert scale scores for each of the ten composite measures on the HSOPS 2.0.

Spearman Rho was used for analysis to identify the direction and strength of relationships between the variables of interest for research question four. Spearman Rho analysis is recommended for variables expressed on an ordinal scale (Kruskal, 2012).

Conclusion

This chapter outlined the methodology for this study. Included was a discussion of the design followed by a discussion of the study settings. The sample was discussed in detail including inclusion and exclusion criteria, calculation of sample size, and sampling and recruitment techniques. Details of the measures used in this study were explored. Finally, a detailed analysis plan was presented.

CHAPTER 4

RESULTS

Chapter 4 discusses the findings related to the study's research questions. It discusses the recruitment and survey participation process, data cleaning, participant characteristics, unit policy, analysis findings for each research question, and post hoc analysis findings.

Recruitment and Survey Participation

A summary of recruitment strategies and results are shown in Figure 4.1. Participants were recruited using multiple methods from August 2024 through April 2025 through random sampling of registered nurses available on state nursing rosters from the states of Alaska, Arizona, Arkansas, California, Iowa, Kansas, Nebraska, New Jersey, and Vermont. The decision to recruit from the available population of registered nurses from multiple state rosters was made to ensure a broader representation of the target population for more robust findings. The PI chose the selected nine states because state nursing rosters were publicly available and affordable to access. The rosters are available online or upon request from each state agency. The rosters include each registered nurse licensee's name, address, and license type. The samples were chosen from the accessible population through the nursing rosters.

During the initial recruitment round, the PI recruited 1,000 randomly selected registered nurses using a web-push technique that involved sending mailed postcards containing the study survey link prior to the survey's opening. The PI's phone number and email address were provided for any participant questions. To complete random sampling for recruitment, the PI assigned a number to each registered nurse listed on the rosters obtained from the state board nursing rosters. The PI created a random computer-generated list of 1,000 numbers. Once the recruitment sample was selected, the PI mailed a postcard to each selected participant using the

address on the roster. The mail correspondence included a summary of the survey purpose, estimated time of completion, inclusion and exclusion criteria, a web address (and QR code) to the survey, and dates that the survey would be available. The PI's phone number and email address were provided for any participant questions. The survey remained open for a period of three months, from August 15, 2024, to November 15, 2024. A reminder postcard was sent to those recruited in October 2024. After the original closing date of November 15, 2024, only 15 surveys were completed.

Due to low participation, the survey was reopened in December 2024, and monthly recruitment of 1,000 randomly selected participants began and continued through April 2025. The PI recruited 1,000 randomly selected registered nurses monthly if there were fewer than the sample size target (84) of completed surveys at the beginning of each month. Monthly recruitment began in December 2024 and ended in April 2025. In total, recruitment postcards were mailed to 6,000 registered nurses. A total of four surveys were completed in December, and 11 records were completed in January.

Due to the continued low response rate, additional convenience sampling recruitment was completed. Convenience sampling was initially avoided because sampling based on availability could potentially decrease the generalizability of a study (Creswell & Creswell, 2017). The decision to proceed with convenience sampling was made due to the low response rate among those recruited via web-push design. The use of convenience sampling was employed to enhance the response rate and engage a broader, more diverse sample (Creswell & Creswell, 2017; Fink, 2013). The PI posted a summary and link to the survey on the Medical-Surgical community group and Global Member Forum on the Circle (Sigma, n.d.-b) on February 25, 2025. The Circle is a community and professional networking site for Sigma. Sigma is an international community

of professional nurses dedicated to advancing knowledge, teaching, learning, and service (Sigma, n.d.-a). The PI chose this site for recruitment due to its more than 100,000 global members, offering a diverse and accessible population of registered nurses. In total, 22 records were completed in February 15 prior to posting on the Circle and seven following the posting. In March, 12 surveys were completed.

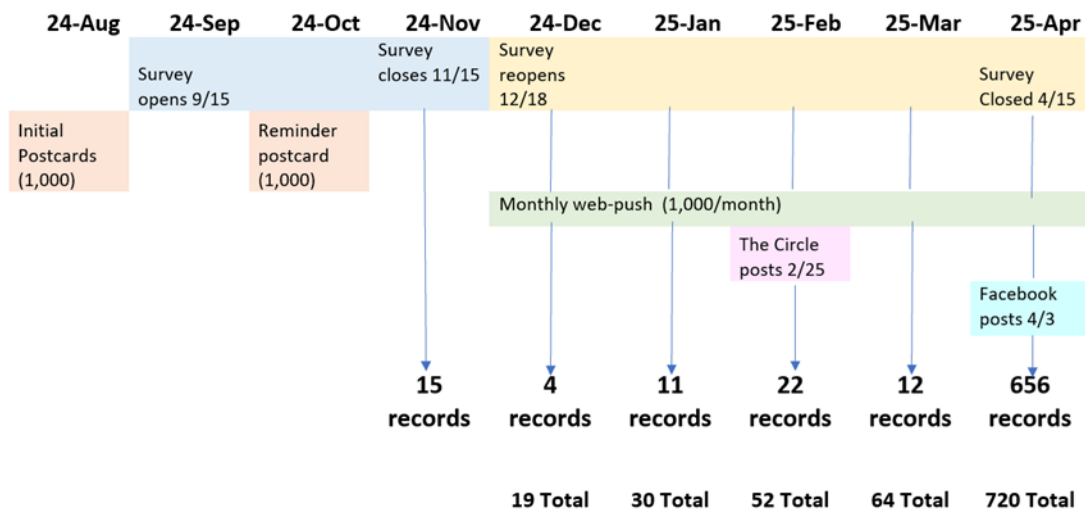
To improve participation, all participants completing the survey in the initial opening period were offered an opportunity to submit their email addresses to be included in a random drawing to win one of 15 \$50 gift cards to encourage higher participation rates. To ensure anonymity remained for those who chose to enter an email address to be entered in the drawing for the gift cards, the email addresses were collected in a separate file from survey responses via a link provided at the end of the survey, and no other information was collected beyond the email address. Following the initial survey closing, fewer than 15 email addresses were obtained, and so all received a gift card. Once the drawing was completed, gift cards were rewarded via the email provided in the link and the email address records were deleted. After reopening the survey due to poor initial participation, a \$10 gift card was offered to the first 100 survey respondents. Again, the email addresses were collected in a separate file from survey responses via a link provided at the end of the survey, and no other information was collected beyond the email address. The first 100 participants to provide an email address received a gift card via email, and their email address records were deleted.

Due to continued low participation, additional recruitment efforts were also undertaken by posting a summary and link to the survey on the PI's personal Facebook page and the open Facebook group, Nurse Life Community (Nurse Life Community, n.d.), on April 3, 2025. The Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA)

option was activated to decrease the risk of a spambot survey attack. Nurse Life Community is a public Facebook group with 26.3K members, catering to individuals with a passion for nursing and healthcare. It is open to nursing professionals, students, and those interested in the profession. Despite following all posted rules, the posting was removed from the Facebook group page, and the PI was blocked. Upon reviewing the page by a third party, the post was no longer visible on the group page. It is unknown if anyone utilized the link prior to this occurrence. In total, 656 surveys were completed in April 2025, all of which were completed after the Facebook recruitment posts were made.

Figure 4.1

Flow Diagram of Recruitment



Data Cleaning

Because this survey was open to the public and the link was posted on social media during recruitment, extensive data cleaning was completed to identify any potentially fraudulent records (Comachio et al., 2024). The Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) was enabled for the survey as a first line of defense (von Ahn et al., 2003). Any record that was deemed potentially fraudulent during cleaning was removed.

Prior to data cleaning, a total of 720 records were recorded. Following all data cleaning processes, 259 records remained. The 13 steps of data cleaning are delineated in Table 4.1.

Table 4.1

Summary of Data Cleaning

	Review Action	Removed	Remaining
	Initial Records (Captcha enabled before Facebook posts)		720
Step 1	Missing consent	45	675
Step 2	Missing screening	70	605
Step 3	Completion < 2 minutes	47	558
Step 4	Shared IP address with record completed in < 2 minutes	17	541
Step 5	Completion < 3 minutes and shared IP address with another record	11	530
Step 6	Shared start/stop time with another record	140	390
Step 7	Shared IP address with record removed due to shared start/stop time	5	385
Step 8	Age <19 or >90	1	384
Step 9	Age minus time as RN < 19	23	361
Step 10	Time as RN minus time on unit less than 0	33	328
Step 11	Lack of variability in answers	0	328
Step 12	Missing > 10% data	69	259
Step 13	5 or more records with similar time to complete (within 3 seconds)	0	259

First, all entries without the required data were removed. Forty-five records were removed due to lack of consent form.

In step two, all records without completed screening questions were removed. 70 records were removed in this step.

Next, in step three, all records completed in less than two minutes were removed. An indicator of potentially fraudulent activity is temporal events, which include abnormal patterns within the completion time of the survey (Comachio et al., 2024). During pretesting, the shortest survey completion time was five minutes. While response time may be shorter than the time

recorded in the pretesting stage, it was deemed implausible for a completion time of less than two minutes. In total, 47 records were removed.

Next, in step four, all records that shared an IP address with another record completed under two minutes were also removed because an indicator of potential survey spam is multiple records originating from the same Internet Protocol (IP) address, (Comachio et al., 2024). In total 17 records were removed.

Next, in step five, all records that were completed in less than three minutes and shared an IP address with one or more records were removed. Three minutes was deemed an improbable, but possible, time for this survey. Because it was seen as unlikely but possible that a record could be sufficiently completed in this time, records were only removed if they also shared an IP address with one or more records. In total 11 records were removed.

Next, in step six, another temporal event evaluated for was records sharing the same start and stop time. It is unlikely that two or more would share the same start and stop time with a survey of this length. In total 140 records were removed for this reason. Additionally, all records sharing an IP address with one or more records removed during this step were also removed out of caution. In total five records were removed.

In step seven, surveys were evaluated for another potential sign of fraudulent activity, survey has non-confirming responses, meaning the respondent provided an answer that is implausible for a member of the sample population (Comachio et al., 2024). First, the selected age of respondents was reviewed for any response indicating an age less than 19 or more than 80. Nineteen was chosen as the minimum age because this is the minimum expected age to become a registered nurse in the United States (American Nurses Association, 2023). Eighty was chosen as the maximum age because only 2% of the workforce is above age 75 and this number would be

expected to decrease with age (Health Resources & Services Administration, Bureau of Health Workforce, 2022). One record was removed due to a reported age outside of this range.

Next in step eight, non-confirming age of respondents was also reviewed by subtracting the time as a registered nurse by the current age to identify any records that indicated the respondent practiced nursing before the age of 19. In total 23 records were removed.

In step 10, the reported time on the unit was subtracted from the reported time as a registered nurse to identify any record indicating that they worked on the unit prior to becoming a registered nurse which was considered a non-confirming response. In total, 33 records were removed.

Next in step 11, records were evaluated for a lack of variability, such as repeating the same answer for each question is considered improbable and a potential sign of survey fraud (Comachio et al., 2024). All records were reviewed for a lack of variability within the Hospital Survey of Patient Safety Culture Version 2.0 (HSOPS 2.0) portion at the end of the survey. This section was chosen for review as it would be more plausible for consistent answers to exist within the prevalence section. No surveys were identified with this pattern.

In step 12, all records were reviewed for missing data and removed if they were missing more than 10% of responses. In total 69 records were removed due to missing responses.

Finally, in step 13, records were reviewed for similarities in completion time. Because it would be unusual for large groups of records to have completion times within seconds of each other, a histogram of all record completion times was completed and reviewed for groups of five or more records that had completion times within three seconds of each other. No groups were identified and thus no records were removed during this step.

Participant Characteristics

A summary of participant demographics can be found in Table 4.2 and Table 4.3.

Table 4.2

Sample Demographics (n=259)

Characteristic	n*	Range	Mean	Median	SD
Age	252	22-80	32.73	30.00	8.181
Time as RN	259	Between 6 months and 1 year – 44 years	7.23	6.00	6.242
Time on Unit	248	<6 months – 30 years	4.25	3.00	3.796

Note. *Not all characteristics equal 461 due to missing data

Table 4.3

Sample Demographics (n=259)

Characteristics	n (%)
Gender	
Female	143 (55.2%)
Male	112 (43.2%)
Non-Binary	2 (0.8%)
Other	0 (0.0%)
Missing	2 (0.8%)
Race	
White	128 (49.4%)
Black or African American	100 (38.6%)
American Indian or Alaska Native	11 (4.2%)
Asian	5 (1.9%)
Multiple or Other	6 (2.3%)
Native Hawaiian or Other Pacific Islander	4 (1.5%)
Missing	5 (1.9%)
Ethnicity	
Not Hispanic, Latino, or Spanish Origin	210 (81.1%)
Hispanic, Latino, or Spanish Origin	44 (17.0%)
Missing response	5 (1.9%)
Highest level of Education completed	
Bachelor's degree	132 (51.0%)
Master's degree	88 (34.0%)
Associate degree	14 (5.4%)

Characteristics	n (%)
Doctoral Degree	22 (8.5%)
Missing	3 (1.2%)
Type of Work Unit	
Medical-Surgical	50 (19.3%)
Intensive care	46 (17.8%)
Acute Rehab	45 (17.4%)
Labor and delivery	21 (8.1%)
Long-term acute	24 (9.3%)
Nursery	14 (5.4%)
Pediatric	26 (10.0%)
Progressive or step-down	5 (1.9%)
Postpartum	5 (1.9%)
Other	7 (2.7%)
Telemetry	4 (1.5%)
Inpatient psychiatric	3 (1.2%)
Neonatal intensive care	2 (0.8%)
Missing	7 (2.7%)
Current Position	
Staff	124 (47.9%)
Charge Nurse	101 (39.0%)
Floor supervisor or manager	24 (9.3%)
Traveling Nurse	8 (3.1%)
Missing	2 (0.8%)

The majority of participants were female (55.2%, n=143), white (49.4%, n=128), and had a mean age of 32.73 (range=22-80, SD=8.181) years. The most common level of education was a bachelor's degree (51%, n=132). The majority of participants worked on medical-surgical unit (19.3%, n=50) in the staff nurse position (47.9%, n=124). The time as a registered nurse averaged 7.23 years (range= between 6 months and 1 year - 44 years, SD = 6.242). The average time on the unit was 4.25 years (range= less than 6 months -30 years, SD=3.796).

Unit Policy

Participants were asked to provide the medication administration timing policy for acceptable administration timeframes employed by their work units. A summary of this information can be found in Table 4.4. Acute care facilities are required to have both time-

critical and non-time-critical medication timing policies in place, so information was collected on each (State Operations Manual – CMS, 2020). Unit timing policies provide an acceptable amount of time medications may be administered early or late without being considered an error.

Table 4.4

Unit Policy (n=259)

Unit Policy Timeframe Allowed	n (%)
Time-Critical Medications	
15 Minutes	52 (20.1%)
30 Minutes	77 (29.7%)
60 Minutes	83 (32.0%)
120 Minutes	33 (12.7%)
Another Timeframe	14 (5.4%)
Unsure or Didn't Know	0 (0.0%)
Missing	0 (0.0%)
Non-Time-Critical Medications	
15 Minutes	20 (7.7%)
30 Minutes	53 (20.5%)
60 Minutes	106 (40.9%)
120 Minutes	59 (22.8%)
Another Timeframe	20 (7.7%)
Unsure or Didn't Know	1 (0.4%)
Missing	0 (0.0%)

The most common timeframe allowed for time-critical medications was 60 minutes (32%, n=83), followed closely by 30 minutes (29.7%, n=77). Other timeframes identified were 15 minutes (20.1%, n=52) and 120-minutes (12.7%, n=33). Additionally, 5.4% (n=14) indicated that their unit had “another” timeframe outside of the choices provided. No participants indicated that they did not know the time-critical medication timing policy for their unit.

For non-time-critical medication policies, 60 minutes was the most common timeframe allowed (40.9%, n=106). Additionally, 22.8% (n=59) indicated a timeframe of 120 minutes, 20.5% (n=53) reported 30 minutes, and 7.7% (n=20) reported 15 minutes. Additionally, 7.7%

(n=20) indicated that their unit had “another” timeframe outside of the choices provided. Only 0.4% (n=1) of participants indicated they were unsure or did not know the non-time-critical medication timing policy for their unit.

Prevalence of Medication Administration Timing Error

Research Question 1: What is the individual and unit prevalence of medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units? A summary of the results is shown in Tables 4.5 and 4.6.

Time-critical Medications

Table 4.5

Prevalence of Medication Administration Timing Error: Time-critical Medications (n=259)

Event Prevalence	n (%)
Individual	
75-100%	15 (5.8%)
50-74%	76 (29.3%)
25-49%	83 (32.0%)
0-24%	84 (32.4%)
Missing	1 (0.4%)
Unit level on-time administration	
Never	2 (0.8%)
Rarely	12 (4.6%)
Occasionally	48 (18.5%)
Frequently	102 (39.4%)
Always	91 (35.1%)
Unsure or Didn't know	3 (1.2%)
Missing	1 (0.4%)

Individual

Regarding the administration of time-critical medications within the allowed timeframe by the individual nurse, 5.8% (n=15) indicated that 75-100% of their time-critical medication

administrations were administered outside of the approved timeframe. A higher percentage (29.3%, n=76) of individual nurses indicated that they administer 50-74% of their time-critical medications outside the timeframe. More participants, 32.0% (n=83), indicated they administer 25-49% of time-critical medications outside of the timeframe. Finally, the highest percentage of participants, 32.4% (n=84), indicated they administer 0-24% of time-critical medications outside of the timeframe. As seen by these results, 67.1% (n=174) of nurses self-report administering time-critical medications outside of the allowed timeframe at least 25% of the time, and 35.1% (n=91) report administering time-critical medications outside the timeframe at least 50% of the time.

Table 4.6

Prevalence of Medication Administration Timing Error: Non-time-critical Medications (n=259)

Event Prevalence	n (%)
Individual error	
75-100%	18 (6.9%)
50-74%	87 (33.6%)
25-49%	74 (28.6%)
0-24%	80 (30.9%)
Missing	0 (0.0%)
Unit level on-time administration	
Never	4 (1.5%)
Rarely	30 (11.6%)
Occasionally	48 (18.5%)
Frequently	91 (35.1%)
Always	80 (30.9%)
Unsure or Didn't Know	3 (1.2%)
Missing	3 (1.2%)

Unit

When examining the unit on which the nurse worked when administering time-critical medications within the allowed timeframe, it was indicated that on 0.8% (n=2) of units, medications were “Never” administered within the timeframe. In addition, on 4.6% (n=12) of units, medications were “Rarely” administered on time; on 18.5% (n=48) of units, medications were “Occasionally” administered on time; on 39.4% (n=102) of units, medications were “Frequently” administered on time; and on 35.1% (91) of units, medications were “Always” administered on time. An additional 1.2% (n=3) indicated they were unsure or “didn’t know” how frequently medications were administered on time on their unit. As identified by these results, 23.9% (n=62) of participants indicated that time-critical medications were administered on time either “Never,” “Rarely,” or “Occasionally.” Participants indicated that time-critical medications were “Never” or “Rarely” on time 5.4% of the time (n=14).

Non-time-critical Medications

Individual

When examining the actions of individual nurses on acute care units when administering non-time-critical medications within the allowed timeframe by the individual nurse, 6.9% (18) indicated that they administer 75-100% of their non-time-critical medications outside of the allowed timeframe. In total 33.6% (n=87) indicated they administer 50-74% of medications outside the allowed timeframe, 28.6% (n=74) administer 25-49% of non-time-critical medications outside the allowed timeframe, while 30.9% (n=80) administer 0-24% of their medications outside of the allowed timeframe. As seen by these results, 69.1% (n=179) of nurses self-report administering non-time-critical medications outside of the allowed timeframe at least

25% of the time, and 40.5% (n=105) report administering time-critical medications outside the timeframe at least 50% of the time.

Unit

When examining the unit on which the nurse works for administering of non-time-critical medications within the allowed timeframe, it was indicated that on 1.5% (n=4) of units, medications were “Never” administered within the timeframe; on 11.6% (n=30) of units, medications were “Rarely” administered on time; on 18.5% (n=48) of units, medications were “Occasionally” administered on time; on 35.1% (n=91) of units, medications were “Frequently” administered on time; and on 30.9% (n=80) of units, medications were “Always” administered on time. An additional 1.2% (n=3) indicated they were unsure or “didn’t know” how frequently medications were administered on time on the unit. As seen in the results, 31.6% (n=82) of participants indicated that non-time-critical medications on their unit were administered on time either “Never,” “Rarely,” or “Occasionally.” Participants indicated that time-critical medications were “Never” or “Rarely” on time 13.1% (n=34) of the time.

Prevalence of Underreporting Timing Error on Acute Care Units

Research Question 2: What is the individual and unit prevalence of underreporting medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units? A summary of the results is shown in Tables 4.7 and 4.8.

Time-critical Medications

Individual

When examining underreporting of time-critical medication timing errors by the individual nurse, 18.5% (n=48) indicated 75-100% of their time-critical medication

administration timing errors were not reported. More participants indicated (29%, n=75) that they do not report 50-74% of their time-critical medication administration timing errors. Additionally, 33.6% (n=87) indicated they do not report 25-49% of their time-critical medication administration timing errors, and 18.5% (n=48) indicated they do not complete an error report for 0-24% of medications administered outside the timeframe. As seen by these results, 81.1% (n=210) of participants indicate that they do not report at least 25% of time-critical medication administration timing errors, and 47.5% (n=123) do not report at least 50% of their time-critical medication administration timing errors.

Table 4.7

*Prevalence of Medication Administration Timing Error Underreporting:
Time-critical (n=259)*

Event Prevalence	n (%)
75-100%	48 (18.5%)
50-74%	75 (29.0%)
25-49%	87 (33.6%)
0-24%	48 (18.5%)
Missing	1 (0.4%)
Unit level reporting	
Never	9 (3.5%)
Rarely	42 (16.2%)
Occasionally	65 (25.1%)
Frequently	76 (29.3%)
Always	60 (23.2%)
Unsure or Didn't know	5 (1.9%)
Missing	2 (0.8%)

Unit

When examining the unit on which the nurse works regarding reporting time-critical medication administration timing errors, it was indicated that on 3.5% (n=9) of units, error reports were “Never” completed when medications were administered outside of the timeframe. In addition, on 16.2% (n=42) of units, error reports were “Rarely” completed for medications

administered outside of the timeframe. On 25.1% (n=65) of units, error reports were “Occasionally” completed for medications administered outside the timeframe. On 29.3% (n=76)

Table 4.8

Prevalence of Medication Administration Timing Error Underreporting: Non-time-critical (n=259)

Event Prevalence	n (%)
Individual underreporting	
75-100%	54 (20.8%)
50-74%	81 (31.3%)
25-49%	83 (32.0%)
0-24%	39 (15.1%)
Missing	2 (0.8%)
Unit level reporting	
Never	18 (6.9%)
Rarely	50 (19.3%)
Occasionally	61 (23.6%)
Frequently	72 (27.8%)
Always	50 (19.3%)
Unsure or Didn't know	6 (2.3%)
Missing	2 (0.8%)

of units, error reports were “Frequently” completed. Finally, on 23.2% (n=60) of units, error reports were “Always” completed when medications were administered outside of the timeframe. An additional 1.9% (n=5) indicated they were unsure or “didn’t know” how frequently error reports were completed for medications administered outside of the allowed timeframe on the unit. As seen in the results, 44.8% (n=116) of participants indicated that time-critical medications administration errors on their unit were reported either “Never,” “Rarely,” or “Occasionally.” Participants indicated that time-critical medications administration timing errors were reported “Never” or “Rarely” 19.7% (n=51).

Non-time-critical Medications

Individual

When examining the actions of individual nurses regarding underreporting non-time-critical medication administration timing errors, 20.8% (n=54) indicated that they do not complete an error report for 75-100% of non-time-critical medications administered outside of the allowed timeframe. Participants reported that 31.3% (n=81) would not complete a report for 50-74% of non-time-critical medication timing errors. Additionally, 32% (n=83) indicated they would not report 24-49% of non-time-critical medications administered outside the timeframe, and 15.1% (n=39) would not report 0-24% of non-time-critical medication administration timing errors. As seen by these results, 84.1% (n=218) of participants indicated that they would not report at least 25% of their non-time-critical medications administration timing errors, and 52.1% (n=135) would not report at least 50% of their non-time-critical medication administration timing errors.

Unit

When examining the unit on which the nurse works regarding underreporting non-time-critical medication administration timing errors, it was indicated that on 6.9% (n=18) of units, error reports were “Never” completed when medications are administered outside of the timeframe. On 19.3% (n=50) of units, error reports are “Rarely” completed for medications outside of the timeframe. On 23.6% (n=61) of units, error reports are “Occasionally” completed for medications administered outside of the timeframe. On 27.8% (n=72) of units, error reports are completed “Frequently” for medications administered outside of the timeframe. Finally, on 19.3% (n=50) of units, error reports are “Always” completed for medications administered outside of the timeframe. Additionally, 2.3% (n=6) indicated they were unsure or “didn’t know”

how frequently error reports were completed for medications administered outside of the allowed timeframe. As seen in the results, 49.8% (n=129) of participants indicated that non-time-critical medications administration errors on their unit were reported either “Never,” “Rarely,” or “Occasionally.” Participants indicated that non-time-critical medications administration timing errors were reported “Never” or “Rarely” 26.2% (n=68) of the time.

Correlation between Medication Administration

Timing Error and Patient Safety Culture

Research Question 3: What is the correlation of individual and unit prevalence of medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units with patient safety culture? The hypothesis is that a correlation exists between the prevalence of medication administration timing error in acute care units and patient safety culture reported by acute care nurses in those units. A non-directional hypothesis was chosen to provide the opportunity to evaluate the correlation between these variables in either direction, as the relationship has not previously been explored (Polit & Beck, 2022).

Spearman’s Rho analysis was completed to examine the relationship between patient safety and time-critical and non-time-critical medication administration timing error rate for both individuals and the unit. Because Spearman’s Rho is a non-parametric statistical test, normalcy is not assumed (Nahm, 2016). Patient safety was measured by the aggregated mean of the composite measures, which measures the patient safety dimensions of teamwork, staffing and work pace, organizational learning/continuous improvement, response to error, leadership, communication about error, communication openness, reporting, hospital management support for patient safety, and handoffs/information. Time-critical and non-time-critical medication

administration timing error at the individual and unit level as well as time-critical and non-time-critical medication administration timing error at the individual and unit level had significant correlation to multiple dimensions of patient safety culture. Therefore, the null hypothesis was rejected. A summary of results is found in Table 4.9.

Time-critical Medications

Lower prevalence of time-critical medication administration timing error (increased on-time time-critical medication administration) at an individual level had significant weak direct correlation with several dimensions of patient safety culture including teamwork ($\rho = .263$, $p < .01$), communication openness ($\rho = .148$, $p = .017$), leadership ($\rho = .144$, $p = .021$), and handoffs/information exchange ($\rho = .134$, $p = .031$). Decreased prevalence of time-critical medication administration error (increased on-time non-time-critical medication administration) on the unit level had significant weak direct correlation with the dimensions of teamwork ($\rho = .256$, $p < .01$), communication openness ($\rho = .220$, $p < .01$), communication about error ($\rho = .234$, $p < .01$), leadership ($\rho = .146$, $p = .020$), and reporting ($\rho = .246$, $p < .01$), and organizational learning/continuous improvement ($\rho = .162$, $p = .010$).

Non-time-critical Medications

Decreased prevalence of non-time-critical medication administration error (increased on-time non-time-critical medication administration) on an individual level had significant weak direct correlation with the dimensions of teamwork ($\rho = .230$, $p < .01$), handoffs/information exchange ($\rho = .133$, $p = .032$), and response to error ($\rho = .151$, $p = .015$). Decreased prevalence of non-time-critical medication administration error (increased on-time non-time-critical medication administration) on the unit level had significant weak direct correlation with the

Table 4.9

Correlational Analysis: Prevalence of Medication Administration Timing Error and Patient Safety Culture (n=259)

Patient Safety Culture Dimension		On-time medication administration			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Teamwork	Correlation Coefficient	.263**	.230**	.256**	.229**
	Sig (2-tailed)	.000	.000	.000	.000
	n	258	259	255	253
Staffing & work pace	Correlation Coefficient	.100	.094	.055	.048
	Sig (2-tailed)	.110	.132	.384	.450
	n	258	259	255	253
Organizational learning/continuous improvement	Correlation Coefficient	.118	.055	.162**	.128*
	Sig (2-tailed)	.058	.379	.010	.042
	N	258	259	255	253
Response to error	Correlation Coefficient	.109	.151*	.103	.141*
	Sig (2-tailed)	.081	.015	.100	.025
	n	258	259	255	253
Leadership	Correlation Coefficient	.144*	.098	.146*	.134*
	Sig (2-tailed)	.021	.117	.020	.033
	N	258	259	255	253
Communication about error	Correlation Coefficient	.091	-.012	.234**	.220**
	Sig (2-tailed)	.148	.846	.000	.000
	n	257	258	254	252
Communication openness	Correlation Coefficient	.148*	.064	.220**	.194**
	Sig (2-tailed)	.017	.302	.000	.002
	n	258	259	255	253
Reporting	Correlation Coefficient	.062	.018	.246**	.231**
	Sig (2-tailed)	.323	.771	.000	.000
	n	258	259	255	253
Hospital management support for patient safety	Correlation Coefficient	.037	.037	.089	.076
	Sig (2-tailed)	.552	.553	.158	.226
	n	258	259	255	253
Handoffs/information exchange	Correlation Coefficient	.134*	.133*	.087	.048
	Sig (2-tailed)	.031	.032	.167	.449
	n	258	259	255	253

Note. * $p < .05$; ** $p < .01$. Sample size varies due to missing data.

dimensions of reporting ($\rho = .231, p < .01$), communication about error ($\rho = .220, p < .01$), communication openness ($\rho = .194, p < .01$), teamwork ($\rho = .229, p < .01$), leadership ($\rho = .134, p = .033$), response to error ($\rho = .141, p = .025$), and organizational learning/continuous improvement ($\rho = .128, p = .042$).

Correlation between Underreporting Medication Administration

Timing Error and Patient Safety Culture

Research Question 4: What is the correlation of individual and unit prevalence of underreporting medication administration timing error for time-critical and non-time-critical medications on acute care units as reported by acute care nurses working on those units with patient safety culture? The hypothesis is that a correlation exists between the prevalence of medication administration timing error reporting in acute care units and patient safety culture reported by acute care nurses in those units. The relationship between these variables has not been previously examined; therefore, a non-directional hypothesis was chosen to provide the opportunity to evaluate the correlation between these variables in either direction (Polit & Beck, 2022).

Spearman's Rho analysis was completed to examine the relationship between patient safety and the reporting of time-critical and non-time-critical medication administration timing error rate for both individuals and the unit. Patient safety was measured by the aggregated mean of the dimensions of teamwork, staffing and work pace, organizational learning/continuous improvement, response to error, leadership, communication about error, communication openness, reporting, hospital management support for patient safety, and handoffs/information. Time-critical medication administration timing error reporting at the individual and unit level as well as non-time-critical medication administration timing error reporting at the unit level had

significant correlation to patient safety culture dimensions. Therefore, the null hypothesis was rejected for all levels with the exception of individual non-time-critical level at which no significant correlations were identified to patient safety culture. A summary of results can be found in Table 4.10.

Time-critical Medication Reporting

Decreased underreporting (increased reporting) of time-critical medication administration timing error on the individual level had a significant weak direct correlation to the dimensions of reporting ($\rho = .123, p < .01$). Decreased underreporting (increased reporting) of time-critical medication administration error on the unit level had significant weak direct correlations to the dimensions of reporting ($\rho = .284, p < .01$), communication about error ($\rho = .230, p < .01$), and communication openness ($\rho = .165, p < .01$).

Table 4.10

Correlational Analysis: Prevalence of Medication Administration Timing Error Reporting and Patient Safety Culture (n=259)

Patient Safety Culture Dimension		Medication administration timing error reporting			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Teamwork	Correlation Coefficient	-.036	-.048	.119	.013
	Sig (2-tailed)	.562	.440	.060	.843
	n	258	257	252	251
Staffing & work pace	Correlation Coefficient	-.049	.039	.029	.009
	Sig (2-tailed)	.437	.538	.645	.883
	n	258	257	252	251
Organizational learning/continuous improvement	Correlation Coefficient	.075	.064	.090	.083
	Sig (2-tailed)	.228	.304	.154	.189
	n	258	257	252	251
Response to error	Correlation Coefficient	-.027	.056	-.024	-.012
	Sig (2-tailed)	.661	.371	.710	.847
	n	258	257	252	251
Leadership	Correlation Coefficient	-.082	-.009	.009	.007
	Sig (2-tailed)	.192	.884	.885	.918

Patient Safety Culture Dimension		Medication administration timing error reporting			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Communication about error	n	258	257	252	251
	Correlation Coefficient	.051	.091	.230**	.149*
	Sig (2-tailed)	.416	.145	.000	.018
Communication openness	n	257	256	251	250
	Correlation Coefficient	.036	-.011	.165**	.106
	Sig (2-tailed)	.565	.857	.009	.093
Reporting	n	258	257	252	251
	Correlation Coefficient	.123*	.099	.284**	.295**
	Sig (2-tailed)	.049	.113	.000	.000
Hospital management support for patient safety	n	258	257	252	251
	Correlation Coefficient	.054	.039	.028	.055
	Sig (2-tailed)	.389	.531	.654	.383
Handoffs/information exchange	n	258	257	252	251
	Correlation Coefficient	-.061	-.060	-.014	-.074
	Sig (2-tailed)	.325	.337	.823	.244

Note. *p<.05; **p<.01. Sample size varies due to missing data.

Non-time-critical Medication Reporting

Decreased underreporting (increased reporting) of non-time-critical medication administration timing error on the individual level had no significant correlations to the dimensions of patient safety culture. Increased reporting of non-time-critical medication error reporting on the unit level had significant weak direct correlations to reporting ($\rho = .295$, $p < .01$) and communication about error ($\rho = .149$, $p = .081$).

Post Hoc Analysis

Post hoc analyses were completed to identify if other potential relationships existed. Correlational analysis was completed to identify a potential correlation between patient safety rating and the prevalence of medication administration timing error or the reporting of medication administration timing error. Correlational analysis was completed to identify potential correlations between the number of reported safety events and the prevalence of

medication administration timing error or the reporting of medication administration timing error. Finally, a correlational analysis was completed to identify correlations between time-critical and non-time-critical medication administration timing error or time-critical and non-time-critical medication administration timing error reporting.

Patient Safety Rating

Spearman’s rho correlational analysis was completed to identify if a correlation existed between either medication administration timing error prevalence or medication administration timing error reporting prevalence and patient safety rating. Those results can be seen in Tables 4.11 and 4.12.

Table 4.11

Post Hoc Analysis Patient Safety Rating Correlation with Medication Administration Timing Error (n=259)

		Medication administration timing error			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Patient	Correlation Coefficient	-.009	-.125*	.130*	.072
Safety	Sig (2-tailed)	.892	.045	.038	.255
Rating	n	258	259	255	253

Note. *p<.05; **p<.01. Sample size varies due to missing data.

Table 4.12

Post Hoc Analysis Patient Safety Rating Correlation with Medication Administration Timing Error Reporting (n=411)

		Medication administration timing error reporting			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Patient	Correlation Coefficient	.001	.053	.186**	.173**
Safety	Sig (2-tailed)	.991	.402	.003	.006
Rating	n	258	257	252	251

Note. *p<.05; **p<.01. Sample size varies due to missing data.

Medication Administration Timing Error Correlation

Significant weak direct correlations were identified between higher patient safety ratings and decreased prevalence of medication administration timing error at the unit level for time-critical medications ($\rho = .130$, $p = .038$). Additionally, a significant weak indirect correlation was identified at the individual level for non-time-critical medications ($\rho = -.125$, $p = .045$).

Reporting of Medication Administration Timing Error Correlation

Significant weak direct correlations were identified between higher patient safety ratings and increased reporting of medication administration timing error at the unit level for both time-critical medications ($\rho = .186$, $p < .01$) and non-time-critical medications ($\rho = .173$, $p < .01$).

Safety Events Reported

Spearman's Rho analysis was completed to identify if a correlation existed between either medication administration timing error prevalence or medication administration timing error reporting prevalence and number of safety events reported. Those results can be viewed in Tables 4.13 and 4.14.

Medication Administration Timing Error Correlation

There were significant weak inverse correlations between increased number of safety events reported and decreased prevalence of individual time-critical medication error ($\rho = -.233$, $p < .01$) as well as decreased prevalence of individual non-time-critical medication error ($\rho = -.187$, $p = .017$). There were no significant correlations identified between the number of safety events reported and decreased prevalence of unit time-critical or non-time critical medication error.

Table 4.13*Post Hoc Analysis Number of Reported Safety Events (n=410)*

		Medication administration timing error			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Number of Events	Correlation Coefficient	-.233**	-.187**	.001	.108
	Sig (2-tailed)	.000	.003	.987	.088
	n	255	256	252	250

Note. *p<.05; **p<.01. Sample size varies due to missing data.

Table 4.14*Post Hoc Analysis Number of Reported Safety Events (n=408)*

		Medication administration timing error reporting			
		Individual		Unit	
		Time-critical	Non-time-critical	Time-critical	Non-time-critical
Number of Events	Correlation Coefficient	.067	.005	.130*	.167**
	Sig (2-tailed)	.288	.943	.041	.008
	n	255	254	249	248

Note. *p<.05; **p<.01. Sample size varies due to missing data.

Correlation between Time-critical and Non-time-critical Medication Error

Spearman's Rho analyses were completed to identify if a correlation exists between the prevalence of time-critical and non-time-critical medication administration timing error, and/or time-critical and non-time-critical medication administration timing error reporting prevalence. Those results can be found in Table 4.15.

A moderate significant direct correlation exists between the prevalence of individual time-critical medication administration timing error and individual non-time-critical medication administration timing error ($\rho = .543, p < .01$). Additionally, there is a significant moderate direct

correlation between time-critical medication administration timing error on the unit and non-time-critical medication administration timing error on the unit ($\rho = .413$, $p < .01$).

Table 4.15

Post Hoc Analysis Time-critical and Non-time-critical Timing Error Correlation (n=259)

Medication Administration Timing Error		Time-critical individual	Non-time-critical individual	Time-critical unit	Non-time-critical unit
Time-critical individual	Correlation Coefficient	1	.543**		
	Sig (2-tailed)	-	.000		
	n	258	258		
Non-time-critical individual	Correlation Coefficient	.543**	1		
	Sig (2-tailed)	.000	-		
	n	258	258		
Time-critical unit	Correlation Coefficient			1	.413**
	Sig (2-tailed)			-	.000
	n			253	252
Non-time-critical unit	Correlation Coefficient			.413**	1
	Sig (2-tailed)			.000	-
	n			252	253

Note. ** $p < .01$. Sample size varies due to missing data.

Correlation between Time-critical and Non-time-critical Medication Error Reporting

Spearman’s Rho analyses were completed to identify if a correlation exists between the prevalence of time-critical and non-time-critical medication administration timing error reporting. Those results can be found in Table 4.16.

A significant moderate direct correlation exists between the individual prevalence of time-critical medication administration timing error reporting and individual prevalence of non-time-critical medication administration timing error reporting ($\rho = .562$ $p < .01$). A significant moderate direct correlation exists between the prevalence of time-critical medication administration error reporting on the unit and the prevalence of non-time-critical medication administration error reporting on the unit ($\rho = .627$, $p < .01$).

Table 4.16

Post Hoc Analysis Time-critical and Non-time-critical Timing Error Reporting Correlation (n=259)

Medication Administration Timing Error Reporting		Time-critical individual	Non-time-critical individual	Time-critical unit	Non-time-critical unit
Non-time-critical individual	Correlation Coefficient	1	.562**		
	Sig (2-tailed)	-	.000		
	N	257	256		
Non-time-critical individual	Correlation Coefficient	.562**	1		
	Sig (2-tailed)	.000	-		
	N	256	257		
Time-critical unit	Correlation Coefficient			1	.627**
	Sig (2-tailed)			-	.000
	N			251	249
Non-time-critical unit	Correlation Coefficient			.627**	1
	Sig (2-tailed)			.000	-
	n			249	251

Note. **p<.01. Sample size varies due to missing data.

Theoretical Results

High reliability requires a strong safety culture (Oster & Braaton, 2021). Patient safety culture within health care organizations is associated with overall safety culture. Highly reliable healthcare organizations (HRO) value patient safety culture and utilize processes that improve error reporting, teamwork, and collective mindfulness and achieve results through implementation of core HRO theory principles. Results related to HRO theory principles are discussed below.

High reliability organization theory's preoccupation with failure ensures a focus on safety throughout an organization and encourages error reporting (Veazie et al., 2019; Weick et al., 2000a). In an organization that is preoccupied with failure, robust reporting of all errors would be expected. The high rate of underreporting as seen in Table 4.7 and 4.8 indicates a potential failure to achieve this principle for many units. As seen in Table 4.10, this study identified

significant weak direct positive correlations of patient safety dimensions to decreased underreporting of both time-critical and non-time-critical medication administration timing errors at the unit level and to decreased underreporting of time-critical medication administration error at the individual level.

Deference to Expertise, another principle of HRO theory, ensures knowledge from experts at every level of an organization is valued and supports open communication between all team members (Oster & Braaton, 2021). In an organization promoting deference to expertise, improved teamwork and team member communication would be expected. Decreased medication administration timing error had weak direct correlations to the patient safety culture dimension of teamwork for time-critical medications at the reported individual level ($\rho=.263$, $p<.01$) and unit level ($\rho=.256$, $p<.01$) as well as non-time-critical medications at the individual ($\rho=.230$, $p<.01$) and unit level ($\rho=.229$, $p<.01$). Decreased time-critical medication administration timing error at both individual ($\rho=.148$, $p=.017$) and unit level ($\rho=.220$, $p<.01$) and decreased non-time-critical medication administration timing error at the unit level ($\rho=.194$, $p<.01$) had weak significant direct correlations to communication openness. Additionally, deference to expertise ensures effective leadership to share responsibilities and promote teamwork (Oster & Braaton, 2021). Decreased medication administration timing error had significant weak direct correlations to the patient safety culture dimension of leadership for time-critical medications at the individual ($\rho=.144$., $p=.021$) and unit level ($\rho=.146$., $p=.020$), as well as non-time-critical medications at the unit level ($\rho=.134$, $p=.033$).

A healthcare organization with a reluctance to accept simplification understands the interrelatedness between aspects of the complex system (Oster & Braaton, 2021). As seen in Table 4.9 and Table 4.10, decreased medication administration timing error and decreased

underreporting of these errors are associated with multiple patient safety dimensions.

Additionally, as seen in Table 4.15 time-critical and non-time-critical medication administration timing have direct significant correlation with each other, but not strong correlations.

Organizations demonstrating sensitivity to operations promote mindful environments that allow early identification of errors and encourage open communication about errors (Oster & Braaton, 2021). Decreased administration timing error has significant weak direct correlations to the patient safety culture of reporting for time-critical medications ($\rho=.246$ $p<.01$). and non-time-critical medications ($\rho=.231$, $p<.01$) at the unit level. Decreased administration timing error has significant weak direct correlations to the patient safety culture of communication about error for time-critical ($\rho=.234$, $p<.01$) and non-time-critical medications ($\rho=.220$, $p<.01$) at the unit level.

Summary

This chapter presented the results of this descriptive, correlational study. The recruitment and data cleaning process for the online survey were described. Patient characteristics and unit level policies were provided. The prevalences of time-critical and non-time-critical medication administration timing error at the individual and unit level were provided. The prevalence of time-critical and non-time-critical medication administration timing error reporting at the individual and unit level were provided. The results of Spearman's Rho correlational analysis between the dimensions of the HSOPS 2.0 and prevalence of time-critical and non-time critical medication administration timing error at the individual and unit level as well as time-critical and non-time-critical medication administration timing error reporting at the individual and unit level were provided. Post hoc Spearman's Rho correlational analysis results between the patient safety rating and prevalence of time-critical and non-time-critical medication administration timing

error reporting at the individual and unit level as well as time critical and non-time-critical medication administration timing error reporting at the individual and unit level were provided. Post hoc Spearman's Rho correlational analysis results between the number of reported safety events and the prevalence of time-critical and non-time-critical medication administration timing error reporting at the individual and unit level as well as time critical and non-time-critical medication administration timing error reporting at the individual and unit level were provided. Spearman's Rho correlational analysis results between the individual prevalence of time-critical and non-time-critical medication administration timing error as well as between unit prevalence of time-critical and non-time-critical medication administration timing error was provided. Finally, Spearman's Rho correlational analysis results between the individual prevalence of time-critical and non-time-critical medication administration timing error reporting as well as between unit prevalence of time-critical and non-time-critical medication administration timing error reporting was provided. Chapter 5 provides a robust discussion of the results and their implications to nursing practice, theory, and policy.

CHAPTER 5

DISCUSSION

This chapter comprehensively discusses study findings, strengths, limitations, and implications for research, practice, theory, and policy. This descriptive, correlational study described the prevalence of medication administration timing error and medication administration timing error underreporting in acute care as reported by acute care registered nurses and identified their correlation with patient safety culture. To this author's knowledge, this is the first study to evaluate the relationship between patient safety culture and the prevalence of medication administration timing error or medication administration timing error reporting in acute care in the United States.

This study demonstrates an alarming frequency of both medication administration timing error and underreporting of medication administration timing error at both the individual and unit level as reported by acute care nurses in the United States. This study is the first to demonstrate a significant correlation between medication administration timing error prevalence and patient safety culture and between medication administration timing error reporting and patient safety culture.

Prevalence of Medication Administration Timing Error in Acute Care Units

The reported prevalence of both time-critical and non-time-critical medication timing error in this study demonstrates an alarming deviation from the expected "rights" of medication administration in acute care. The high rate of time-critical medication error is particularly concerning given that administration of a time-critical medication more than 30 minutes early or late could lead to harm or substantially inferior therapy (Institute for Safe Medication Practices, 2011). This study identified a concerning frequency of medication administration timing error

with high individual error rates reported by a significant percentage of participants. This finding was not limited to individual errors, as a high percentage of participants also perceived high error rates on their units. Despite the concerning finding, not all units were identified as experiencing a high rate of error, as a significant portion of participants perceived that medications were always administered on time on their units. These findings are consistent with the systematic review of literature by Pullam et al. (2023), which found reported rates of medication administration timing error between 1 and 72.6% globally. This study provides evidence that medication administration timing error is occurring frequently within the United States and at varying rates across units. This heterogeneity in reported prevalence rates may be indicative of systematic breakdown on units with higher rates of error and should be further explored.

Adding to this significant finding is that a large percentage of participants indicated that their units allowed 60 or even 120 minutes before or after a time-critical medication is scheduled for administration. This allows a window two to four times as long as the 60-minute window (30 minutes before or after scheduled time) recommended by the Institute for Safe Medication Practices and CMS guidelines for acute care timing policies (Institute for Safe Medication Practices, 2011; State Operations Manual – CMS, 2020). There may be a potential knowledge deficit, but participants were given the option to indicate they did not know the unit's policy. While knowledge deficit about unit policies on medication timing may be present, this may potentially be complicated by the way policies are presented to staff members. In a study of registered nurses in a major United States veterans' healthcare system, Kelly et al. (2021) found that 75% of nurses had no difficulty accessing policies and protocols in a timely manner, but only 14% found the policies and protocols user-friendly. For those who reported difficulty, time was the most significant barrier. No participants in this study indicated they were unclear on the

time-critical medication timing policy on their unit. The unusual timeframes identified in this study suggests that there is either poor understanding of time-critical policies or that units have unusually lax policies. Either way, this highlights a huge potential issue that must be further examined.

Prevalence of Underreporting of Medication Administration

Timing Error in Acute Care Units

This study explored the underreporting of medication administration timing error and identified a high rate of underreporting. Around half of participants indicated they report 50% or less of their timing errors. A substantial percentage of participants indicated a low rate of medication administration timing error reporting. Underreporting was also identified at the unit level at a high rate. A link to severe harm and death from omitted and delayed dosing and evidence suggests that the rate of harm is higher than identified due to underreporting (National Patient Safety Agency, 2010). To date, this is the first study that describes a prevalence rate for underreporting of medication administration timing error, but previous research by Osborne et al. (1999), in a study investigating appropriate reporting of medication error by nurses, found that it was estimated that only 25% of all medication errors are reported. The high prevalence of underreporting found in this study implies that potential systematic issues may inhibit nurses' reporting behaviors. This failure to report timing errors prevents facilities from identifying the true prevalence and associated factors inhibiting the ability implement improvement strategies. While the rates of underreporting medication administration timing errors have not previously been explored, several barriers to reporting other safety events potentially contributing to the issue have been identified in past research. Barriers to general medication error reporting was identified by Schuermann et al. (2024) in a study exploring the attitudes and perceptions of

nurses toward medication error reporting. Schuermann et al. (2024) found that both internal factors, such as fear of judgment, guilt, or beliefs about error severity, and external factors such as poor reporting processes, negative leadership responses, and unit culture, can prevent nurses from reporting medication errors. Additionally, Rutledge et al. (2018) in a study to identify medication error reporting barriers among hospital nurses in a California hospital, found that the greatest barriers to reporting were related to the time-consuming nature of reporting or fear of repercussions. Additional potential contributing factors that could lead to underreporting safety events were identified in an earlier study by Evans et al. (2006), in a study to identify factors inhibiting reporting of safety incidents in Australian hospitals. Evans et al. (2006) found that staff were more likely to report incidents that were habitually reported, often witnessed, or required interventions. Inadequate feedback and poor reporting processes were identified as major barriers to reporting safety events.

Correlation between Prevalence of Medication Administration

Timing Error and Patient Safety Culture

This study examined the relationship between key dimensions of safety culture and the prevalence of medication administration timing error in acute care as measured by acute care registered nurses' responses to questions from the Hospital Survey of Patient Safety Culture Version 2.0 (HSOPS 2.0) (Sorra et al., 2019). While not all aspects of patient safety culture can be captured in a single tool due to its complexity, the HSOPS 2.0 has been demonstrated to be a valid and reliable instrument to measure known aspects of patient safety culture and was created specifically for the hospital setting (Sorra, n.d.).

The significant direct correlations to multiple patient safety culture dimensions identified in this study indicate that decreased prevalence of medication administration timing error is

associated with the perception of increased patient safety culture in acute care units. Similarly, a link between decreased total medication administration errors and patient safety culture has been demonstrated in past studies. In a Pakistani study to analyze the influence of patient safety culture on medication administration error among nurses and midwives, Anggraini et al. (2024) found that multiple aspects of patient safety culture were associated with a decrease in medication administration error. Additionally, Bastani et al.'s (2024), correlational study of hospital staff in an Iranian hospital system, factors associated with increased medication errors, such as workload fatigue, method of supervision in the hospital units, and a major increase in duties, were found to have negative correlation with patient safety culture, meaning that more factors were present when there was a poorer patient safety culture.

The strongest correlation of decreased time-critical medication administration timing error and non-time-critical medication administration timing error at the individual level was to the patient safety culture dimension of teamwork. This finding indicates that better ability to work as a cohesive team is associated with decreased medication timing errors. While no previous studies have explored the relationship between teamwork and medication administration timing error, teamwork has been positively correlated with improvement of other patient outcomes. Rosen et al. (2018), in a review of literature, highlighted the positive impact of teamwork on patient outcomes and found that teamwork had a positive effect on multiple patient care outcomes. The authors found that effective care teams communicate more effectively about medication timing schedules, support each other during busy times, and have a greater sense of shared responsibility for medication administration.

Also noteworthy was that reported non-time-critical medication administration timing error at the unit level, while significantly correlated to the dimension of teamwork, was more

strongly correlated to reporting. Reporting was also the second strongest correlation to unit level time-critical medications error. Additionally, a decreased reported unit rate of both time-critical and non-time-critical medication administration errors had significant direct correlations of similar strength to communication about error and communication openness. These findings indicate that as these safety factors improved, medication administration timing errors for non-time-critical medications decreased at the unit level. Communication about error ensures staff are informed about and actively involved in the prevention of errors on the unit as well as informed about changes made due to event reports (Sorra et al., 2021). The patient safety culture dimension of reporting focuses on ensuring errors and potential errors are reported on the unit. Finally, communication openness ensures staff feel free to speak up about potential safety issues and that those with authority are open to those concerns. The findings indicate that units with a perception of more inclusive communication, a culture supportive of reporting errors, and a lack of fear around reporting safety issues are also perceived as having a decreased rate of non-time-critical medication administration timing error. Though no study has explored a connection between communication and medication administration timing error specifically, in a systematic review of literature, Keshtkar (2025) found that 13.2% of safety events were caused by poor communication and that poor communication contributed to 24% of safety events.

Stronger correlations at the time-critical level for most dimensions indicate that time-critical medication administration timing is more closely associated with patient safety culture than non-time-critical medication administration timing. Time-critical medications have an increased risk for harm if administered early or late, potentially explaining the stronger correlation to patient safety culture (Institute for Safe Medication Practices, 2011). There were

notable differences in correlations to safety culture and prevalence rates of time-critical and non-time-critical medication administration timing error.

Correlation between Prevalence of Underreported Medication

Administration Timing Error and Patient Safety Culture

There were significant correlations between the reported time-critical and non-time-critical medication administration timing error reporting at the unit level and several patient safety culture dimensions. Additionally, time-critical medication administration timing error reporting at the individual level was correlated to the safety dimension of reporting. No prior studies have explored the relationship between medication administration timing error reporting and patient safety culture, but a secondary data analysis of hospital nurses in a single South Korean hospital by Jang et al. (2021) found that early career nurses reporting a high safety culture were 2.44 times more likely to report medication error. The same effect was not seen in mid-career nurses, however. Additionally, Munn et al. (2023), in a cross-sectional study, identified that improvements in safety climate of organizations were associated with improved reporting of safety events.

Reporting of medication administration timing error was most strongly correlated to the dimension of reporting, which focuses on ensuring errors and potential errors are reported on the unit, regardless of harm (Sorra et al., 2021). This indicates that a higher percentage of medication administration timing errors that occur are reported on units that emphasize the importance of reporting safety events. Though one may anticipate a stronger correlation to reporting, the correlation was weak for both time-critical and non-time-critical medications at both the individual and unit levels, indicating that other factors could be inhibiting reporting such as guilt,

time-consumption, or personal judgment (Evans et al., 2006; Rutledge et al., 2018; Schuermann et al., 2024).

Post Hoc Analysis

Participants that perceived decreased time-critical medication administration timing errors on their work units also perceived their unit as having higher patient safety ratings. Interestingly, a decrease in individual time-critical medication administration timing errors or unit-level non-time-critical medication administration timing error were not associated with improved patient safety ratings. Additionally, a decrease in individual non-time-critical medication administration timing error had a significant weak indirect correlation to the patient safety rating, meaning that as the reported rate of these errors increased, the reported safety rating of the unit decreased. These contradicting correlational findings may indicate that there are factors that differ between time-critical and non-time-critical medications and between unit and individual administration that influence the perception of patient safety rating.

Increased prevalence of reporting time-critical and non-time-critical medication administration timing error at a unit level had significant weak direct correlations with improved patient safety ratings. This finding was not replicated on the individual level, providing further evidence that differences between individual and unit-wide factors may be influential in perceptions of patient safety culture.

Participants who reported more safety events were more likely to have medication administration timing error. Additionally, individuals with more reported safety events were more likely to indicate that medication administration timing errors were reported more frequently on the unit. In contrast, Kaya et al. (2023), in a cross-sectional study, found that those with better patient safety culture were more likely to see increased error reporting, but less likely

to be involved in medical errors. Interestingly, the correlation to reporting medication administration timing errors and reporting of safety events was only identified at the unit level.

The correlation between time-critical and non-time-critical medication administration timing error indicates that an increase or decrease in one type of error is associated with the same in the other. This would indicate that any interventions aimed toward timing errors involving one type of medication would likely affect the other. To this author's knowledge, this is the first time this correlation has been explored, but a previous study evaluated the differences in the rate of error on six acute care units. Furnish et al. (2021), in a retrospective study evaluation of medication administrations, found that time-critical medications were more frequently (69%) administered at the wrong time than non-time-critical medications (84%).

This study found that the increased rate of reporting one type of error was associated with reporting the other. To this author's knowledge, this is the first study to explore a correlation between time-critical and non-time-critical medications. The correlation between time-critical and non-time-critical medications means that changes focused on improving only one type of reporting may have effects on the other.

Strengths

This study had several strengths. The sample size was adequate, exceeding the priori power analysis recommendation, providing increased statistical conclusion validity (Polit & Beck, 2022). Another strength was the use of a validated tool, the Hospital Survey on Patient Safety Culture (HSOPS 2.0), which has been widely recognized for its reliability and effectiveness in assessing patient safety culture within healthcare settings (Sorra et al., 2021). This tool provides a comprehensive framework for evaluating key dimensions of safety culture, contributing to the robustness of the findings.

Limitations

This study had several limitations which must be considered. One significant limitation of this study was the employment of new, previously unvalidated question items to collect prevalence rates for medication administration timing error and medication administration timing error reporting. No previously created and validated tools measuring these prevalence rates were identified in scientific literature. The potential for direct observation through hospital facilities and systems was explored and deemed infeasible due to lack of facilities willing to participate in the study. To address the data collection need, additional survey questions were created by the PI. To mitigate the risks of new untested questions items, pretesting on the survey was completed to identify and correct any identified issues prior to data collection.

Additionally, the necessary use of self-report for data collection meant that there is a risk for social desirability bias causing nurses to answer questions in ways they perceive may be viewed more favorably by the PI (Polit & Beck, 2022). This risk was mitigated by ensuring the anonymity of those responding, providing positive wording within the prevalence of questions, and by providing clear definitions within the survey.

Another limitation of this study was the measurement of unit patient safety culture by individual participant responses rather than the aggregated unit mean. While HSOPS2.0 also utilizes self-report to measure patient safety culture, the suggested method for measurement relies on a representative sample of staff to broadly establish the collective patient safety culture on the unit (Sorra, 2021). This aggregated measurement is necessary to fully identify the attitudes and behaviors that are rewarded and expected within the unit, because patient safety culture exists at multiple levels within healthcare systems. The use of individual perception rather than unit means results in correlations that only reflect the perceived patient safety culture

rather than the true unit-level construct. Supporting this concern, past research has identified that unit rankings vary depending on computation and aggregation methods (Giai et al., 2017) This variation from suggested use introduces a threat to construct validity and generalizability of findings.

Perhaps the most significant limitation was the potential for self-selection bias due to the necessary shift to convenience sampling because of an inadequate response rate after multiple rounds of random sampling recruitment using web-push recruitment. Because convenience sampling does not involve selection from the available population to participate by random chance, there is a risk that extraneous factors that affect the study outcome were present in the sample population but not the study population (Polit & Beck, 2022).

Additionally, because the link to this survey was shared with the public during recruitment, a risk of fraudulent activity was present. Prior to posting the link to social media, the Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) was enabled for the survey as a first line of defense (von Ahn et al., 2003). Prior to analysis, the data were cleaned extensively, removing records deemed potentially fraudulent.

Finally, an additional consideration that may have limited this study was the demographic differences between the sample population and the target population, which may have affected the generalizability of results. There was an overrepresentation of males, making up 43.2% (n=112) of the sample compared to 11.2% in the United States registered nurse population (Smiley et al., 2023). Forty-eight and a half percent of participants in this study identified as non-white (n=126) compared to 20% of registered nurses in the United States. There was a significant overrepresentation of those who identify as black or African American (38.6%, n=100) compared to the registered nurse population (10.2%). Additionally, 17% (n=44) identified as

Hispanic or Latino compared to 6.9% of the registered nurse population. Finally, the sample of this study demonstrated higher education levels than the general population of registered nurses. In the study sample, 34% (n=88) held master's degrees compared to 17.9% of the population, and 8.5% held doctoral degrees (n=22) compared to 2.7% of the population. These differences in demographics between the study sample and the population of interest decreased the external validity of the results, and therefore, results cannot be generalized to the general population (Polit & Beck, 2022).

Implications

The results of this study have numerous implications for research, practice, theory, and policy. These implications are discussed next.

Research

This novel study provides a robust foundation for future research on medication administration timing error prevalence, medication administration timing error reporting prevalence, and their relationship to patient safety culture. This study highlights the high rate of timing error and low rate of reporting such errors and identifies a correlation between the reported prevalence of medication administration timing error and multiple dimensions of patient safety culture in acute care.

Qualitative evaluation of key concepts within this study can provide more clarification on the effect of patient safety culture dimensions on medication administration timing error and its reporting. Specifically, this approach can improve operational understanding of how associated factors manifest during patient care and how they can influence individual's decision and ability to report these errors. Qualitative methods are more likely to identify patient safety culture dimensions not covered by standard survey format, enriches the exploration of complex issues

related to safety culture, and can provide insight to identify areas for improvement (Churruca et al., 2021).

Additionally, future exploration of this study's findings using more specific measurement tools to obtain prevalence rates, through observational or electronic record data collection, will provide more rigorous scientific evidence of these relationships with patient safety culture dimensions and improve clarity on the prevalence of medication administration timing error and underreporting. Retrospective review of electronic medication administration records in facilities using bar-code scanning devices to administer medications would provide a more accurate prevalence rate of timing errors, since there would not be a reliance on self-report, which introduces bias. This method, while improved, may still provide some inaccuracies as bar-code scanning alerts have previously been found to be overridden on 10.3% of medications, and medications may be scanned prior to or after administration occurs (Koppel et al., 2008). The gold standard, observation, which involves a trained provider actively observing medication administrations, has been consistently identified to recognize more occurring medication errors (Manias, 2013). This more accurate data can be compared to the number of reported medication administration timing errors through review of electronic system or through count of non-electronic reports.

Further exploration of the relationship between time-critical and non-time-critical medications is needed to better understand the specific issues and needs involved in the administration of each. Exploration of the statistical correlation between occurrences of each type of medication administration timing error using observation or retroactive chart review could provide more valid data for comparison (Koppel et al., 2008; Manias, 2013). The data

could also provide an opportunity to evaluate shared underlying factors present for both types of errors.

Finally, the relationship to patient safety culture dimensions identified in this study can be further explored using the retroactive chart review or observation. In addition to empirical validation of this study's finding using more robust techniques, interventional research to reduce medication administration timing error in acute care may focus on previously identified factors, such as interruptions or heavy workload and barriers to safety event reporting such as time-consuming processes and fear (Assunção-Costa et al., 2022; Rutledge et al., 2018; Soydemir et al., 2017; Taufiq et al., 2015).

Practice

This study provides evidence on medication administration timing error and reporting, a previously understudied area of nursing care. The high prevalence of medication administration timing error identified in this study is especially alarming for time-critical medications due to the increased risk of harm to patients and should be the most immediate focus for facilities. This is supported by the requirement of acute care facilities to have specific timing policies in place for both time-critical and non-time-critical medications (Operations Manual – CMS, 2020). Furthermore, time-critical medications must be specifically identified within facility policies due to the increased risk of harm from an early or late administration and are required to be given within 30 minutes before or after the scheduled time. Inpatient units should regularly evaluate timing policies and front-line workers' knowledge of such policies. Units should also ensure that appropriate monitoring is in place to accurately capture the extent of the issue. This is regulated by CMS, which sets an expectation that all acute care medication errors are to be reported to

their quality assessment and performance improvement (QAPI) program (Centers for Medicare & Medicaid Services, 2011).

Quality improvement initiatives on units experiencing higher rates of medication administration timing error should aim to improve targeted patient safety culture factors and cultivate a strong culture of teamwork. Medication errors are not simply individual errors, but instead are symptoms of larger systematic problems such as poor communication and inadequate staffing that require interventions to strengthen teamwork (Hammoudi et al., 2018). Effective teamwork has been linked to better patient outcomes, through improved communication and team support (Rosen et al., 2018). Additionally, improved teamwork is associated with increased clinical error reporting (Hwang & Ahn, 2015).

Barriers to reporting should be examined and mitigated. Safety event reporting should be looked at as an opportunity for learning and improvement rather than a punitive intervention. Reframing failures as learning opportunities rather than seeking blame improves understanding of expectations and meaning throughout organizations (Oster et al., 2021). This study found that decreased medication timing error as reported at the individual level is associated with higher rates of safety incident reporting, suggesting a culture supportive of error reporting may lead to decreases in overall error. This was further supported at the unit level with evidence of a relationship between decreased error and improved perception of the patient safety culture dimension of reporting. Increased error reporting is associated with increased patient safety culture and decreased medical error (Kaya et al., 2023).

Theory

High reliability organization (HRO) theory was used to guide this study. The findings further support its use in establishing this study as well as the importance of HRO theory in healthcare practice, especially when examining the medication administration process.

An HRO is preoccupied with failure, meaning they focus on recognizing, preventing, and improving issues on an ongoing basis (Sutcliffe, 2011). This study provides evidence that improved reporting practices are associated with decreased medication administration timing error. Robust reporting of medication timing error in acute care is a tangible manifestation of this preoccupation, and this study demonstrates that many units are perceived to be falling short on this practice by the registered nurses administering medications on those units.

High reliability organizations are reluctant to accept simplification and recognize the complexity and interrelatedness of the system in which error occurs (Oster et al., 2021). This is supported by correlational findings between time-critical and non-time-critical medications, indicating both interrelated and unique factors for each. A complex relationship is demonstrated by the high but widely varying prevalence rates identified for both medication administration timing error and its reporting as well as their correlation to multiple patient safety culture dimensions. These findings indicate that medication administration timing error improvement must be tackled at a systematic level due to its complexity.

High reliability organizations also defer to expertise, meaning that experts provide insight into complex issues while ensuring open communication (Oster et al., 2016). In acute care units, front-line workers are frequently the most knowledgeable about day-to-day operations. High reliability organizations ensure workers are able to share expertise to improve processes.

Improved teamwork was associated with decreased medication administration timing error and increased medication administration timing error reporting, further demonstrating this principle.

High reliability organizations demonstrate sensitivity to operations, meaning that they understand the importance of daily processes and potential hazards involved (Oster et al., 2016). Inadequate error reporting leads to poor sensitivity to operations. This study identified a potential deficit in this theory principle's application within the acute care medication process as demonstrated by the high rate of underreporting coupled with a high rate of error.

Policy

The complexity of the medication process along with the correlation of medication administration timing error and its underreporting to multiple dimensions of patient safety culture indicate a need to approach medication administration timing error and its reporting systematically. Hospitals are required by CMS to ensure QAPI programs reflect the complexity of their organization and services and work toward a culture of safety (Centers for Medicare & Medicaid Services, 2023). Furthermore, a culture of safety minimizes fear of blame, a known factor for underreporting safety events (Kohn et al., 2000; Soydemir, 2017).

The concerning rate of error reported by participants for both individual and unit medication administration timing error as well as underreporting indicates that facilities may have an inaccurate picture of this issue and facility policies for reporting may be insufficient in their current state. Adding to the concern is the discrepancy between CMS and ISMP recommendations and the reported unit timing policies related to time-critical medication administration, indicating that facilities may need to review and update current policies or ensure dissemination to those administering medications (Institute for Safe Medication Practices, 2011; State Operations Manual – CMS, 2020).

An additional factor in medication administration timing error that should be explored is the feasibility of unit timing policies currently in place. While CMS requires facilities to administer medications they have identified as time-critical within 30 minutes of the scheduled administration time, non-time-critical medications can typically be safely administered within two hours (Institute for Safe Medication Practices, 2011; State Operations Manual – CMS, 2020). More than one in four respondents in this study identified a unit policy requiring non-time-critical medications to be administered within 30 or even 15 minutes of the scheduled time. Facilities may want to examine potentially relaxing non-time-critical policies to ensure that the expectations are feasible and not an undue burden diverting nurses from patient care needs that should be prioritized.

Conclusion

A review of literature found that research on medication administration timing error was still in the descriptive stage, but that it was a common issue identified in acute care globally. This descriptive, correlational study sought to identify the prevalence of medication administration timing error, identify the prevalence of underreporting medication administration timing error, and explore correlations with patient safety culture among registered nurses in acute care.

The reported prevalence of individual and unit level medication administration timing error reported by acute care registered nurses was high for time-critical and non-time-critical medications, indicating a need for action in acute care units. There was heterogeneity in reported unit prevalence, suggesting systematic differences between units may be affecting timely medication administration. Decreased prevalence of medication administration was correlated to several patient safety culture dimensions, increasing the significance of the results. The strongest correlation was identified with the dimension of teamwork, which measures the effectiveness

and cohesiveness of the unit team, providing initial focus for interventions aimed at improvement.

Unfortunately, there is a high reported prevalence of underreporting of medication administration timing error in acute care units. The ability to fully understand the issue on individual units or as a national healthcare issue is hindered by poor reporting processes and procedures. There was heterogeneity in the reported prevalence, suggesting that systematic differences between units may affect reporting habits. Reporting of medication administration timing error was correlated with multiple dimensions of patient safety culture. The prevalence of reporting was most strongly correlated with the dimension of reporting which focuses on facilitating and improving reporting processes. This provides an area of focus for quality improvement initiatives aimed at improving reporting rates.

Post hoc analysis identified several important findings. The correlation between the reported prevalence of time-critical and non-time-critical medications suggests that efforts in one area may affect both. Time-critical medications were more strongly correlated to patient safety culture and are more likely to cause harm if administered outside of the appropriate time. These findings indicate that time-critical medication should be the initial focus of safety initiatives. More reported safety events were associated with less reported medication administration timing error, indicating that improved reporting processes may also lead to decreased error overall. A higher prevalence of reported error on the unit, but not individually, was associated with a higher rate of individually reported safety events.

This study adds foundational research knowledge to the body of literature. The findings in this study provide robust opportunities for advancements in research, nursing practice, nursing policy, and nursing theory.

APPENDIX A

LITERATURE REVIEW ARTICLES

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
Assunção-Costa et al. (2022).	Purpose: Determine the incidence, nature, and factors associated with medication administration errors observed in a university hospital Design: Prospective observational Theory: None	Sample: 561 drug doses Percent Male: None Reported Mean Age: None Reported Ethnicity: None Reported Setting: Public university hospital, Northeast Brazil, two units: medical and surgical. February 2019	Definition: >60 minutes before/after scheduled or >30 minutes before/after scheduled if to be given with/before/after meal/food. Measures: Percentage of administrations Procedure: Direct-disguised observation	Prevalence: Medication administration timing error 11.1% (62/561) Causes: Interruptions were the main associated factor and 2 times more likely to cause a timing error Consequences: Not Measured
Bagheri-Nesami et al. (2015)	Purpose: Determine frequency of IV administration errors and their causes in cardiac critical care units. Design: Descriptive Theory: None	Sample: n= 190 nurses; 20,240 doses of IV medication. Patients: Percent Male: 63.2% (1606/2542) Mean Age: 60.87 ± 13.25 Ethnicity: Not Reported Nurses: Percent Male: 7.8% (15/190) Mean Age: 33.96 ± 6.61 Ethnicity: Not Reported Setting: 12 teaching hospitals, critical care units, Iran; November 2014-January 2015	Definition: Unclear Measure: Percentage of all (IV) errors Procedure: Self-administered questionnaires.	Prevalence: Wrong time errors 3.1% (8/262) of total errors reported. Cause: Measured but not segregated by type Consequence: Measured but not segregated by type
Barker et al. (2002)	Purpose: Identify prevalence of medication errors Design: Prospective cohort Theory: None	Sample: n = 36 institutions; 3216 doses; 1 med pass minimum over 1-4 days (high med-volume units) Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: 36 facilities in Denver-Boulder-Greeley, Colorado, and Atlanta, Georgia metropolitan statistical area; 7-month study period	Definition: >60 minutes before/after scheduled time or 30 minutes before after dosing with meal Measure: Percentage of administrations. Procedure: Observation	Prevalence – Wrong time errors 8% (259/3216) overall; 6% (85/1481) in accredited hospitals and 11% (31/284) in non-accredited Cause: not measured Consequence: 15% of wrong time errors were judged to have potential clinical significance
Berdot et al. (2012)	Purpose: Determine incidence, type, and clinical importance of drug administration errors and identify risk factors Design: Descriptive/exploratory	Sample: n= 28 nurses, 108 patients, 1501 observed administrations Patients Percent Male: not reported Mean Age: not reported Ethnicity not reported	Definition: >60 min before/after schedule Measure: Percentage of administration errors Procedure: Observation	Prevalence: wrong time errors: 72.6% of total errors (312/430) Cause: Measured but not segregated by type of error

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
	Theory: None	Nurses: Percent Male: 0% Mean Age: 29 (range 21-50) Ethnicity: not reported Setting: 4 wards of an 800-bed teaching hospital; Paris, France		Consequences: Measured but not segregated by type of error
Bohomol et al. (2009)	Purpose: Investigate incidence, types, causes, and consequences of medication errors. Design: Exploratory, quantitative Theory: None	Sample: n=44 adult inpatients, ICU Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: ICU Inpatient, single facility, 30-day period, 2006.	Definition: > 15 minutes after scheduled time for medications scheduled for every 4, 6, 8 or 12 hours, or > 30 minutes for daily doses. Measures: Percentage of all medication errors. Procedure: Anonymous self-report, staff screening, review of patient charts.	Prevalence: 35/305 wrong time errors occurred 11.5% (2nd highest frequency of medication error). Causes: Stated but not segregated to type of error Consequences: Stated but not segregated to type of error.
Calabrese et al. (2001)	Purpose: Measure incidence and specify types of medication administration errors from a list of error-prone medications and to determine if patient harm resulted from these errors. Design: Descriptive Theory: None	Sample: n = 5,744 medication administration observations in 851 patients. utilized error prone medications observation and evaluation for harm. Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: 3-month time period, July-October, 1999. Five USA ICUs. 2 observations per day per patient.	Definition: >60 min before/after schedule Measure: Percentage of administration errors. Procedure: Observation of medication administration	Prevalence – 13.9% (26/187) of errors were wrong time errors Cause: not measured Consequences – Measured but not segregated by type of error
Chua, Chua et al. (2009)	Purpose: determine extent and types of drug administration errors in two pediatric wards and identify measures to reduce such errors Design: Descriptive Theory: None	Sample: n= 857 drug administrations Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: Two paediatric wards, teaching hospital, Malaysia	Definition: >60 minutes before/after scheduled dose Measure: Percentage of administration errors. Procedure: Observation	Prevalence: wrong-time most common (28.8%)30/104 error Causes: Stated but not segregated to type Consequences: not measured
Chua, Tea et al. (2009)	Purpose: Determine frequency and types of drug administration errors. Design: Prospective cohort/ descriptive Theory: None	Sample: n= 1118 medication administrations/ opportunities Patients: Percent Male: Not reported Mean Age: Not Reported Ethnicity: Not reported Setting: 22-bed Haematology ward of teaching hospital in Malaysia. 8 weeks, November 2004- January 2005 with 15 working days (each Wed/Friday excluding one holiday) from 0730-2100	Definition: >60 minutes before/after scheduled dose. Measure: Percentage of administration errors. Procedure: Undisguised observation	Prevalence: 34/127 errors 25.2% Cause: Not measured Consequences: Not measured

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
Ernawati et al. (2014)	Purpose: Determine nature and frequency of medication errors during medication delivery processes Design: Prospective cohort Theory: None	Sample: n= 92 patients/ 770 drug orders/ 7662 drug dose Percent Male: 60% (55/92) Mean Age: 71.4±7.5 years Ethnicity: Not reported Setting: 13-bed geriatric ward, public teaching hospital, Bali, Indonesia	Definition: Unclear Measure: Percentage of administration errors. Procedure: Observation	Prevalence: 35/927 (3.78%) errors were wrong time Cause: Measured but not segregated by type of error Consequences: Measured but not segregated by type of error
Feleke et al. (2015)	Purpose: Assess magnitude/associated factors of medication administration errors Design: Prospective observational, cross-sectional Theory: None	Sample: n= 360 medication administrations, 82 nurses, and 263 patients. Patients: Percent Male: 46.4% (122/263) Mean Age: Not reported Ethnicity: Not reported Nurses: Percent Male: 15.9% (13/82) Mean Age: 31 ± 6.4 Ethnicity: Not reported Setting: Felege Hiwot (Ethiopia), Referral Hospital. Inpatient Department. March 24-April 7, 2014.	Definition: >30 min before/after schedule Measure: Percentage of medications administered. Procedures: Observation, survey	Prevalence: Timing errors 193/360 (53.6%) Cause: Measured but not segregated by type of error. Consequences: not measured
FitzHenry et al. (2007)	Purpose: Identify errors in CPOE environment. Design: Descriptive Theory: None	Sample: n=190 patient charts Percent Male: Not reported Mean Age: 64 Ethnicity: Not reported Setting: Vanderbilt University Hospital, Nashville, TN; adult sub-acute, acute, and CCU; 1999-2003	Definition: >60 minutes before/after scheduled. Measures: Percentage of administrations, percentage of orders. Procedure: Retrospective chart review	Prevalence: 916/5426 (dose) administrations; 16.9% wrong time errors 646/1502 orders; 43% wrong time errors. Causes: not measured Consequences: not measured.
Furnish et al. (2021)	Purpose: Determine whether there was a difference in meeting medication administration goals when comparing time-critical to non-time-critical scheduled medication administration in both intensive care units (ICUs) and general medical floors at a large, academic medical center. Design: Retrospective Theory: None	Sample: Electronic medical record charge data, time-critical 69,405 and non-time-critical 389 administrations Percent Male: None Reported Mean Age: None Reported Ethnicity: None Reported Settings: 6 inpatient nursing units, Single University Hospital, Colorado, USA. June 1-30, 2017	Definitions: > 60 minutes before/after schedule for time-critical; > 120 minutes before/after schedule for non-time-critical Measures: Percentage of time-critical medications administered on time; percentage of non-time-critical medications administered on time. These measurements include RT administrations. A comparison of the percentage of RN vs. RT on-time medication	Prevalence: Non-time-critical medication administrations 16% (11,306/69405); Time-critical medication administration error 31% (268/389); RN medication administration timing error 16% (raw number not provided). ICU medication administration timing error 11% (raw number not provided), med-surg medication administration timing error 23% (raw number not provided). Causes: Not Measured Consequences: Not Measured

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
			administration is provided as well as a comparison of ICU and med-surg on-time medication administration. Procedure: Data extraction from electronic health record- (generated reports providing a list of all medications administered outside of allowed time window validated for accuracy against medication dispensing system.)	
Hernandez et al. (2015)	Purpose: Assess impact of the implementation of (CPOE) associated with pharmacy checks of medication orders in 3 stages of drug management. Design: Quasi-experimental Theory: None	Sample: n=111 pre-implementation patient charts and 86 post-implementation patient charts, 1593 pre-implementation medication orders and 1388 post-implementation medication orders Percent Male: Pre-implementation 46% (51/111); Post implementation 44.2% (38/86) Mean Age: Pre-implementation 64 (range 48-81); Post-implementation 61 (range 44-83) Ethnicity: Not reported Setting: Paris, France, 66-bed orthopaedic surgery ward, 700-bed teaching hospital. Pre-implementation observation two 24-hour periods (Jan 15–16th 2013 and Feb 28th-Mar 1st, 2013), post-implementation observation period (Jun 17–18th 2013 and Jul 3–4 th 2013).	Definition: 60 minutes before/after schedule Measure: Percentage of administrations. Procedure: Pre/Post observation study utilizing patient charts and medication dispensing	Prevalence: Timing errors pre-implementation 8/1222 (0.7%) post-implementation 28/1413 (2%) Causes: Study measured CPOE implementation as a potential cause. Overall CPOE lead to a 17.5% significant decrease in administration errors and a 65% increase in timing errors. Consequences: Not measured
Hicks et al. (2004)	Purpose: Summarize study records from USP's MEDMARX database of medication errors for 2002 Design: Summary of data Theory: None	Sample n= 192,477 medication error records (482 participating facilities) Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: MEDMARX database of medication errors, 2002.	Definition: Not defined – Reported from facilities. Measure: Percentage of all errors. Procedure: Review of MEDMARX database	Prevalence: timing errors 6.9% (83,753/192,477) of all reported medication errors Cause: Measured but not segregated by type of error Consequence: 1% (121/83,753) of all timing errors caused harm
Lisby et al. (2005)	Purpose: To investigate the frequency, type, and consequences of medication errors in more stages of the medication process, including discharge summaries. Design: Cross-sectional	Sample: n= 64 patients in-hospital; 2467 opportunities for errors Percent Male: 46.9% (30/64) Mean Age: Medical ward- 55 (95% CI: 48–62); Surgical ward, 62 (95% CI: 56–68) Ethnicity: Not reported Setting: One medical-surgical unit in Denmark; January-April, 2003	Definition: Unclear – utilized guideline Measure: Percentage of administration errors. Procedures: Direct observation, control visits, chart reviews	Prevalence: Wrong time medication errors 10.8% (18/166) Cause: not measured Consequences: Measured but not segregated by type of error

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
	Theory: None			
Loput et al. (2022)	<p>Purpose: Determine the frequency of medication administration timing variances for specific therapeutic classes of high-risk medications using data extracted from a health-system clinical data warehouse (CDW) is presented.</p> <p>Design: Retrospective</p> <p>Theory: None</p>	<p>Sample: Data extraction from clinical data warehouse of a large healthcare system, 5,690,770 medication administrations</p> <p>Demographics:</p> <p>Patients</p> <p>Percent Male 48.3% (2,743,974)</p> <p>Mean Age: Scheduled 64/ PRN 56</p> <p>Ethnicity/ Race: White 65.5% (3,724,842)</p> <p>Black 16.4% (930,574)</p> <p>Hispanic Other 6.6% (377,468)</p> <p>Hispanic White 6.1% (346,923)</p> <p>Unknown/ Other 5.5% (310,963)</p> <p>Setting: Clinical data warehouse of large healthcare system, USA including urban and suburban community hospitals. August 1, 2017 – July 31, 2018.</p>	<p>Definition: No explicit definition stated, parameters provided for data measurement of 30-59 minutes, 60-120 minutes, and >120 minutes for data extraction purposes.</p> <p>Measures: Measure of interest - percentage of medications administrations delayed 60 minutes or greater between the hours of 7 a.m. and 7 p.m.</p> <p>Procedure: Data extraction from CDW of medication administrations (from therapeutic classes of antimicrobials, opioids, benzodiazepines, anticoagulants/antiplatelets, nonopioid combination analgesics, and insulins (chosen to limit size of data abstraction) as well as delayed administration data. For 30-59 minutes, 60-120 minutes and >120 minutes. Additionally, PRN medication administrations were extracted along with early administrations of 30-59 minutes, 60-120 minutes, and >120 minutes. Timing of errors as well as therapeutic class of errors were evaluated within the study.)</p>	<p>Prevalence: Medication administration delays of 60 or more minutes between the hours of 7 a.m. and 7 p.m. of included medications 21% (458,415/2,138,690)</p> <p>Causes: While no cause was explicitly stated, it was noted that there was a significant difference in delay, 44.9% of administration delays (275,257) of 60 or more minutes occurred during the hours of 9 a.m. -10 a.m. or 9 p.m. - 10 p.m.</p> <p>Consequences: Not measured</p>
Mohammed et al. (2022)	<p>Purpose: Assess the magnitude and contributing factors of medication administration errors among nurses in federal hospitals in Addis Ababa, Ethiopia.</p> <p>Design: Cross-sectional</p>	<p>Sample: 423 Nurses</p> <p>Demographics:</p> <p>Nurses</p> <p>Mean Age Not provided</p> <p>Highest percentage 25-29 47.8% (192/423)</p> <p>%male 39.1% (157/423)</p> <p>Ethnicity/Race: Not Provided</p>	<p>Definition: >30 minutes Before/After scheduled time</p> <p>Measures: Percentage of nurses reporting committing the medication error in the last 12 months (prior to the survey).</p>	<p>Prevalence: Medication administration timing error 56.8% (raw number not provided). Most common type of medication error identified.</p> <p>Causes: Not measured</p> <p>Consequences: Not measured</p>

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
	Theory: None	Setting: Federal hospitals Addis Ababa City, Ethiopia, July – August 2021.	Procedure: Self-administered questionnaire	
Morelock & Kirk (2019)	Purpose: identify patterns of medication errors with respect to shifts, day of week, unit involve, severity, medication class and cause of errors and propose possible solutions. Design: Retrospective exploratory Theory: None	Sample: n= 605 medication events Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: 2 urban medical centers, North Texas; January 2016- July 2017	Definition: Unclear Measure: Percentage of administration errors. Procedure: Data abstraction from self- reports	Prevalence: Early 106 (17.5%); Late 132 (21.8%) (when combined as wrong-time this most common) Causes: Stated but not segregated to type of administration error. Consequences: Stated but not segregated to type of administration error.
Noguchi et al. (2016)	Purpose: Clarify epidemiology of medical errors and risk factors for non-intercepted and unidentified medical errors. Design: Prospective cohort study (Longitudinal) Theory: None	Sample: n= 3459 patients Percent Male: 57% (1948/3459) Mean Age: 62% >65 years (2155/3459) Ethnicity: Not reported Setting: Three tertiary teaching hospital; Adult medical and surgical wards, Japan; January-June, 2004	Definition: Unclear Measure: Percentage of medication errors. Procedure: Data abstraction	Prevalence: Wrong time 5 total errors (1.0 %) Cause: Not measured Consequences: Not measured
Poon et al. (2010)	Purpose: Identify changes in error rates with bar-code implementation Design: Before/after quasi experimental Theory: None	Sample: n= 14041 medication administrations, 6723 without bar-code and 7318 with barcode; 3082 order transcriptions Patients: Percent Male: Medical unit without bar code 53% (n not reported); with bar code 48% (n not reported); Surgical unit without bar code 54% (n not reported); with barcode 53% (n not reported) Intensive care unit without bar code 53% (n not reported); with barcode 51% (n not reported) Mean Age: Medical unit without bar code 64.3±17.1; with bar code 64.6±16.5; Surgical unit without barcode 58.5±17.0; with barcode 58.4±17.8; Intensive care unit without barcode 62.4±16.7; with barcode 61.3±15.3 Ethnicity: Not reported Nurses: Not reported Percent Male: Not reported Mean Age: Not reported Ethnicity Not reported Setting: One 735 bed tertiary academic facility, 35 adult medical-surgical and intensive care units, 9 months 2005. USA	Definition: >60 minutes before/after scheduled, Measure: Percentage of errors in administrations. Procedure: Observation	Prevalence: before barcode 16.7% (1126/6723) without barcode; 12.2% (1126/7318) with 891 barcode (27.3% reduction) Causes: Not measured – Interventional Consequences: Not measured - Interventional

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
Ramya & Vineetha (2013)	Purpose: Determine defined medication error, commonly observed types, drugs involved, and causes. Study barriers to reporting medication errors. Design: descriptive/exploratory survey Theory: None	Sample: n=50 nurses with minimum one year experience Percent Male: 14% (7/50) Mean Age: Not reported Ethnicity: Not reported Setting: Indian facility, cardiac wing, tertiary care teaching hospital; January – February 2013	Definition: >60 min before/after schedule. Measure: Percentage of administration errors. Procedure: Exploratory survey	Prevalence: Self-reported wrong-time medication administration observation was 13% of reported errors. Causes: Stated but not segregated by type of error Consequences: not measured Other: Barriers of reporting stated but not segregated by type.
Tabatabaee et al. (2022)	Purpose: Investigate the prevalence and types of medication errors among nurses in a hospital in northeastern Iran. Design: Cross-sectional, Descriptive analysis Theory: None	Sample: 147 medical records, 57 nurses, 955 doctor's orders Demographics: Nurse Mean age 34 % male 30 (17/57) Ethnicity/Race: Not provided Setting: Hospital, Northeastern Iran, 2019	Definition: None given Measures: percentage of all errors Procedure: Data abstraction from medical record (Medical record review utilizing predefined checklist)	Prevalence: Medication administration timing error 5.6% (20/356) of all errors Causes: Not measured Consequences: Not measured
Taufiq et al. (2015)	Purpose: Measure of the prevalence and contributing factors of wrong time medication administration errors via electronic medical administration record. Design: Descriptive Theory: None	Sample: n= 250,213 observed doses Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: Tertiary care hospital in Pakistan, 5 inpatient areas medical, surgical, coronary care, intensive care, and pediatric units (37% of total inpatient bed); 3-month period Feb 10, 2012-May 9, 2012.	Definition: Unclear Measure: Percentage of doses Procedure: Abstraction of data via electronic medication administration record	Prevalence: 39,386 wrong-time administration/ 231,380 administered doses (17%). Causes: Early administration: Nurse related: no reasons given 30.4% no reason given, 31.8% unclear reasons; Patient related: 5.6% due to patient condition, .8% patient wanted to sleep early; system related: 54.4% pre-meal requirement; 1.9% due to planned procedure; 1.05% per doctor order. Misc. reasons 4.3% Late medications Pharmacy related: 12.2% med late from pharmacy; nursing related: Nurse busy 11.5%; 6.4% forgot to document; 21.4% no reason; 8.4% on time but updated late; Patient related: sleeping 3.6%, refusal 2.9%, patient gone 2.9%; System related: emergency use of medication and later refurbished from pharmacy 2.3%; Medication administration time dependent of

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
				procedure 4.2%, multiple IV medications at same time 3.8%; other and technical 3.7% technical issues, misc. 2.6% Consequences: not measured.
Tissot et al. (1999)	Purpose: Assess type, frequency, and potential clinical significance of medication-administration errors Design: Prospective Theory: None	Sample n= 2009 nursing medication administrations, 26 patients. Percent Male: Not reported Mean Age: Not reported Ethnicity: Not Reported Setting 3-unit, 15-bed medical ICU, University Hospital, Besancon, France, 30 days during a 2-month period.	Definition: >60 min before/after schedule Measure: Percentage of administrations. Procedure: Observation	Prevalence: Wrong time errors 3.7% (9/243) of administrations. Cause: not measured. Consequences: These errors were potentially clinically significant (55.5%)
Tolley et al. (2022)	Purpose: To assess the impact of a novel medication scanning device (MedEye) on the rate of medication administration errors in a large UK Hospital. Design: Before and after feasibility study Theory: None	Sample: 35 drug rounds, 1,069 medication administrations before MedEye intervention, 432 medication administrations following MedEye intervention, 19 nurses. Demographics: Nurses Mean Age none provided but majority noted to be between 26-35 or 46-55. \$male: Not provided Ethnicity/Race: Not provided Setting: 30-bed respiratory medical ward at a tertiary-care teaching hospital Trust in a large UK hospital.	Definition:>60 minutes before/after scheduled Measures: Percentage of administrations Procedure: Blind observation of medication administrations by nurses followed by review of order. Each recorded error was reviewed by two trained observers and classified.	Prevalence: Medication administration timing errors pre-intervention 64.4% (688/1,069); Medication administration timing errors post-interventions 67.4% (291/432) Causes: Not measured Consequences: Not Measured
Tsegaye et al. (2020)	Purpose: Assess medication administration errors and associated factors Design: Cross-sectional Theory: None	Sample: n= 414 nurses Percent Male: 45.7% (189/414) Mean Age: 30 years with interquartile range (IQR)27–33 years. Ethnicity: Not reported Setting: Ethiopia, referral hospitals of Amhara regional state. March 1-30, 2019	Definition: Defined as not administered at scheduled time Measure: Percentage of nurses reporting a wrong-time medication error as a percentage of overall administrations. Procedures: Observation/ Self-report	Prevalence: Wrong time 38.6% 62/414 Cause: Measured but not segregated by type of error Consequences: Not Measured
Welton et al. (2018).	Purpose: Test ability to use large data set to extract time-referenced data to identify medication late doses and PRN administration patterns by RNs in inpatient setting	Sample: n=3,043,812 doses, 50,883 patients, 714 nurses Patients: Percent Male: 49.3% (25097/50832) Mean Age: 39 (Range 0-102) Ethnicity: Hispanic/Latino 42.1% (20999/50832); White 40.6% (20249/50832); African American 14% (6984/50832); Asian 1% (1455/50832); Other or Unknown 1.3% (639/50832); American/Alaskan Native 1.2% (557/50832)	Definition: 60 minutes before/after schedule Measure: Percentage of scheduled meds.. Procedure: Data extraction from electronic health record	Prevalence: Average of late medications per shift 12.1%; anti-infective were 11.8-12.9% late (60 min) and 30.1-32.7% late (30 min); insulin and anticoagulant 9.4-11.1% late 60 minutes and 19.2-27.7% (30 min). Total of measured medications given late 70,584

Author /Year/ Title	Purpose/ Design/ Theory	Sample/ Patient Demographics/ Setting	Definitions/ Measures/ Procedure	Prevalence/ Causes/ Consequences/ Other
	Design: Retrospective, exploratory Theory: None	Nurses: Percent Male: Not reported Mean Age: Not reported Ethnicity: Not reported Setting: Single urban 525-bed hospital; 11 inpatient units; Western state, April 1, 2013-March 31, 2015		(6.47%) (60 min) and 177,650 (16.28%) (30 min) of a total of 1,204,445 administration opportunities. Causes: Not measured Consequences: Not measured
Westbrook et al. (2010)	Purpose: Test hypothesis that interruptions during medication administration increase errors. Design: Descriptive Theory: None	Sample: n= 98 nurses, 4271 medications, 720 patients Patients: Percent Male: Not reported Mean Age: Hospital A - 72.6 years (95% CI, 71.1-74.0); Hospital B - 67.5 years (95% CI, 65.0- 70.0) Ethnicity: Not Reported Nurses: Percent Male: Not reported Mean Age: Not reported Ethnicity: Not Reported Setting: 6 wards in 2 teaching hospitals; Sydney, Australia; 505 hours from September 2006 through March 2008.	Definition: >60 min before/after schedule, or >30 minutes before/after if scheduled with meal Measure: Percentage of administrations. Procedure: Observation	Prevalence: wrong-time errors 16.1% (688/4271) Cause: not measured Consequence: major errors (severity) occurred in 4.1% of wrong-time errors
Wondmieneh et al. (2020)	Purpose: Assess magnitude and contributing factors of medication administration error among nurses in tertiary care hospitals. Design: Cross-sectional Theory: None	Sample: n=298 nurses, 225 medication doses. Percent Male: 33.6% (100/298) Mean Age: 27.2 years, SD =5.1 Ethnicity: Not Reported Setting: Addis Adaba, Ethiopia, February-March, 2018	Definition: >60 min before/after schedule Measure: Percentage of errors in administrations. Procedures: Self-administered questionnaires. Observation	Prevalence: observation 44.7% wrong-time errors. Last 12 months, 57.8% (117/298) nurses reported having at least 1 wrong-time error Causes: Measured but not segregated by type of error Consequences: Not measured.

APPENDIX B

SUPPLEMENTAL DIGITAL CONTENT TABLE 2: QUALITY OF REPORTING SCORES

	Item #	Bagheri-Nesami et al. (2015)	Barker et al. (2002)	Berdot et al. (2012)	BohoMol. (2009)	Calabrese et al. (2001)	Chua et al. (2009a)	Chua et al. (2009b)	Ernawati et al. (2014)	Feleke et al. (2015)	FitzHenry et al. (2007)	Hernandez et al. (2015)	Hicks et al. (2004)	Lidzy et al. (2005)	Morelock and Kirk (2019)	Naguchi et al. (2016)	Poon et al. (2010)	Ramya & Vineetha (2014)	Taufiq (2015)	Tsot et al. (1999)	Tsegaye et al. (2020)	Welton et al. (2018)	Westbrook et al. (2010)	Wondmieni (2020)
Title and abstract	a	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	b	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
Introduction																								
Background/rationale	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Objectives	3	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
Methods																								
Study design	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Setting	5	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
Participants	a	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1
	b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Variables	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Data sources/ measurement	8	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Bias	9	1	1	1	1	0	1	1	0	1	0	1	0	0	1	1	1	0	1	0	1	1	1	1
Study size	10	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1
Quantitative variables	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Statistical methods	a	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
	b	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
	c	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	d	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	1	0	1	0	0
	e	0	0	0	1	0	1	1	0	1	0	1	0	1	1	1	1	0	0	0	1	0	1	1
Results																								
Participants	a	1	0	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
	b	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0
	c	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0
Descriptive data	a	1	0	1	0	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1
	b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
	c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Outcome data	15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Main results	a	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	b	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other analyses	17	0	1	1	0	0	1	1	1	1	1	1	0	1	1	1	0	1	0	0	1	0	1	1
Discussion																								
Key results	18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
Limitations	19	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0	1	1	1	1
Interpretation	20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1
Generalisability	21	0	0	1	1	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1
Other information																								
Funding	22	0	0	1	1	0	1	1	0	1	1	1	0	0	1	1	1	0	0	0	1	0	1	1
Total	34	19	21	23	20	19	18	25	21	26	24	27	19	25	23	24	24	18	15	18	27	20	27	25

APPENDIX C

SCREENING QUESTIONS

1. Have you worked on an acute care (inpatient) unit or floor (including but not limited to medical-surgical units, specialty inpatient units, Intensive Care Unit of any type, labor and delivery, pediatrics, acute rehab, long-term acute care) for at least 30 days?
 Yes
 No
2. Have you been responsible for medication administration within the last 30 days on acute care unit?
 Yes
 No
3. On average, how many hours do you work on your inpatient unit each week?
 less than 24 hours
 24 hours
 32 hours
 36 hours
 40 hours
 48 hours
 more than 48 hours
4. Does your work unit have a policy for timing of administration for time-critical (time-sensitive) medications? (Time-critical medications include medications that must be delivered within a very specific timeframe due to their critical effect and/or the increased potential for harm if given outside of a specific timeframe. This may include medications such as insulin, anticoagulants, medications that are ordered to be given STAT, or medications that are ordered to be given frequently such as every four hours)
 Yes
 No
 Unsure
5. Does your work unit have a policy for timing of administration for non-time critical medications? (Non-time-critical medications are medications that may have a larger timeframe for administration. This may include medications that are ordered daily or less frequently such as daily or twice daily antihypertensive medication.)
 Yes
 No
 Unsure

APPENDIX D

DEMOGRAPHIC SURVEY QUESTIONS

Please complete the following demographic questions. Your answers to all questions are anonymous.

1) What is your gender?

- Male
- Female
- Non-Binary
- Other

2) What is your age in years? _____ (includes a scroll box with numbers from 16-99)

3) What is your race?

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Multiple or Other

4) What is your ethnicity?

- Hispanic or Latino or Spanish Origin
- Not Hispanic or Latino or Spanish Origin

5) What is the highest level of education you have completed?

- Associate Degree
- Bachelor Degree
- Master Degree
- Doctoral Degree

6) How long have you been a registered nurse? _____ (includes a scroll box with less than 6 months, between 6 months and 1 year, 1 year–50 years, greater than 50 years)

7) What type of unit do you currently work on? _____

- Medical-Surgical (including specialized inpatient units such as orthopedic, neurological, and cardiac)
- Intensive care (including medical-surgical care, cardiac care, and neurological care)
- Progressive or step-down
- Telemetry

- Pediatric
- Labor and delivery
- Postpartum
- Nursery
- Neonatal intensive care
- Inpatient psychiatric
- Acute Rehab
- Long-term Acute
- Other

8) How long have you worked on your current unit? _____ (includes a scroll box with less than 6 months, between 6 months and 1 year, 1 year–50 years, greater than 50 years)

9) Which of the following best describes your current position in your unit?

- Staff
- Charge Nurse
- Floor Supervisor or Manager
- Traveling Nurse

APPENDIX E

UNIT POLICY QUESTIONS

1. In your work unit, per policy, what is the maximum timeframe allowed to administer time-critical (time-sensitive) medications? Medications should be administered within:
 - 15 minutes before or after a medication is scheduled
 - 30 minutes before or after a medication is scheduled
 - 60 minutes before or after a medication is scheduled
 - 120 minutes before or after a medication is scheduled
 - Other timeframe before or after a medication is scheduled

2. In your work unit, per policy, what is the maximum timeframe allowed to administer non-time-critical (non-time-sensitive) medications? Medications should be administered within
 - 15 minutes before or after a medication is scheduled
 - 30 minutes before or after a medication is scheduled
 - 60 minutes before or after a medication is scheduled
 - 120 minutes before or after a medication is scheduled
 - Other timeframe before or after a medication is scheduled

APPENDIX F

PREVALENCE OF MEDICATION ADMINISTRATION TIMING ERROR QUESTIONS

To the best of your knowledge how frequently are the following completed by nursing staff (including you) on your unit?

1. Time-critical (time-sensitive) medication administration within the allowed timeframe before or after schedule time?
 - always
 - frequently
 - occasionally
 - rarely
 - never

2. Non-time-critical medication administration within the allowed timeframe before or after schedule time?
 - always
 - frequently
 - occasionally
 - rarely
 - never

To the best of your knowledge how frequently are the following completed by you personally?

1. Time-critical (time-sensitive) medication administration within the allowed timeframe before or after schedule time?
 - 0-25%
 - 26-50%
 - 51-75%
 - 76-100%.

2. Non-time-critical medication administered within the allowed timeframe before or after schedule time?
 - 0-25%
 - 26-50%
 - 51-75%
 - 76-100%.

APPENDIX G

PREVALENCE OF UNDERREPORTING OF MEDICATION ADMINISTRATION

TIMING ERROR QUESTIONS

To the best of your knowledge how frequently are the following completed by nursing staff (including you) on your unit?

1. Reporting of time-critical (time-sensitive) medication administration outside of the allowed timeframe before or after schedule time?
 - always
 - frequently
 - occasionally
 - rarely
 - never.

2. Reporting of non-time-critical medication administration outside of the allowed timeframe before or after schedule time?
 - always
 - frequently
 - occasionally
 - rarely
 - never

To the best of your knowledge how frequently are the following completed by you personally?

1. Reporting of time-critical (time-sensitive) medication administration outside of the allowed timeframe before or after schedule time?
 - 0-25%
 - 26-50%
 - 51-75%
 - 76-100%.

2. Reporting of non-time-critical medications administration outside of the allowed timeframe before or after schedule time?
 - 0-25%
 - 26-50%
 - 51-75%
 - 76-100%.

APPENDIX H

HSOPS 2.0 SURVEY QUESTIONS

SOPS® Hospital Survey

Version: 2.0

Language: English

- For more information on getting started, selecting a sample, determining data collection methods, establishing data collection procedures, conducting a web-based survey, and preparing and analyzing data, and producing reports, please read the [Hospital Survey Version 2.0 User's Guide](#).
- For the survey items grouped according to the safety culture composite measures they are intended to assess, please refer to the [Hospital Survey Version 2.0 Items and Composite Measures](#) document.
- To participate in the AHRQ Hospital Survey on Patient Safety Culture Database, you must have administered the survey in its entirety without modifications or deletions:
 - No changes to any of the survey item text and response options.
 - No reordering of survey items.
 - Questions added only at the end of the survey after Section F, before the Background Questions section.

For assistance with this survey, please contact the SOPS Help Line at 1-888-324-9749 or SafetyCultureSurveys@westat.com.



Hospital Survey on Patient Safety (Version 2.0)

Instructions

This survey asks for your opinions about patient safety issues, medical error, and event reporting in your hospital and will take about 10-15 minutes to complete. If a question does not apply to you or your hospital or you don't know the answer, please select "Does Not Apply or Don't Know."

- **"Patient safety"** is defined as the avoidance and prevention of patient injuries or adverse events resulting from the processes of healthcare delivery.
- A **"patient safety event"** is defined as any type of healthcare-related error, mistake, or incident, regardless of whether or not it results in patient harm.

Your Staff Position

1. What is your position in this hospital?

Select ONE answer.

Nursing

- 1 Advanced Practice Nurse (NP, CRNA, CNS, CNM)
- 2 Licensed Vocational Nurse (LVN), Licensed Practical Nurse (LPN)
- 3 Patient Care Aide, Hospital Aide, Nursing Assistant
- 4 Registered Nurse (RN)

Medical

- 5 Physician Assistant
- 6 Resident, Intern
- 7 Physician, Attending, Hospitalist

Other Clinical Position

- 8 Dietitian
- 9 Pharmacist, Pharmacy Technician
- 10 Physical, Occupational, or Speech Therapist
- 11 Psychologist
- 12 Respiratory Therapist
- 13 Social Worker
- 14 Technologist, Technician (e.g., EKG, Lab, Radiology)

Supervisor, Manager, Clinical Leader, Senior Leader

- 15 Supervisor, Manager, Department Manager, Clinical Leader, Administrator, Director
- 16 Senior Leader, Executive, C-Suite

Support

- 17 Facilities
- 18 Food Services
- 19 Housekeeping, Environmental Services
- 20 Information Technology, Health Information Services, Clinical Informatics
- 21 Security
- 22 Transporter
- 23 Unit Clerk, Secretary, Receptionist, Office Staff

Other

- 24 Other, please specify:

Your Unit/Work Area

2. Think of your "unit" as the work area, department, or clinical area of the hospital where you spend most of your work time. What is your primary unit or work area in this hospital?

Select ONE answer.

Multiple Units, No specific unit

- 1 Many different hospital units, No specific unit

Medical/Surgical Units

- 2 Combined Medical/Surgical Unit
- 3 Medical Unit (Non-Surgical)
- 4 Surgical Unit

Patient Care Units

- 5 Cardiology
- 6 Emergency Department, Observation, Short Stay
- 7 Gastroenterology
- 8 ICU (all adult types)
- 9 Labor & Delivery, Obstetrics & Gynecology
- 10 Oncology, Hematology
- 11 Pediatrics (including NICU, PICU)
- 12 Psychiatry, Behavioral Health
- 13 Pulmonology
- 14 Rehabilitation, Physical Medicine
- 15 Telemetry

Surgical Services

- 16 Anesthesiology
- 17 Endoscopy, Colonoscopy
- 18 Pre Op, Operating Room/Suite, PACU/Post Op, Peri Op

Clinical Services

- 19 Pathology, Lab
- 20 Pharmacy
- 21 Radiology, Imaging
- 22 Respiratory Therapy
- 23 Social Services, Case Management, Discharge Planning

Administration/Management

- 24 Administration, Management
- 25 Financial Services, Billing
- 26 Human Resources, Training
- 27 Information Technology, Health Information Management, Clinical Informatics
- 28 Quality, Risk Management, Patient Safety

Support Services

- 29 Admitting/Registration
- 30 Food Services, Dietary
- 31 Housekeeping, Environmental Services, Facilities
- 32 Security Services
- 33 Transport

Other

- 34 Other, please specify:

SECTION A: Your Unit/Work Area

How much do you agree or disagree with the following statements about your unit/work area?

Think about your unit/work area:	Strongly Disagree ▼	Disagree ▼	Neither Agree nor Disagree ▼	Agree ▼	Strongly Agree ▼	Does Not Apply or Don't Know ▼
1. In this unit, we work together as an effective team.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
2. In this unit, we have enough staff to handle the workload.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
3. Staff in this unit work longer hours than is best for patient care.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
4. This unit regularly reviews work processes to determine if changes are needed to improve patient safety.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
5. This unit relies too much on temporary, float, or PRN staff.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
6. In this unit, staff feel like their mistakes are held against them.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
7. When an event is reported in this unit, it feels like the person is being written up, not the problem.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
8. During busy times, staff in this unit help each other.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
9. There is a problem with disrespectful behavior by those working in this unit.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
10. When staff make errors, this unit focuses on learning rather than blaming individuals.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
11. The work pace in this unit is so rushed that it negatively affects patient safety.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
12. In this unit, changes to improve patient safety are evaluated to see how well they worked.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
13. In this unit, there is a lack of support for staff involved in patient safety errors.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
14. This unit lets the same patient safety problems keep happening.....	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9

SECTION B: Your Supervisor, Manager, or Clinical Leader

How much do you agree or disagree with the following statements about your immediate supervisor, manager, or clinical leader?

	Strongly Disagree ▼	Disagree ▼	Neither Agree nor Disagree ▼	Agree ▼	Strongly Agree ▼	Does Not Apply or Don't Know ▼
1. My supervisor, manager, or clinical leader seriously considers staff suggestions for improving patient safety	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
2. My supervisor, manager, or clinical leader wants us to work faster during busy times, even if it means taking shortcuts	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
3. My supervisor, manager, or clinical leader takes action to address patient safety concerns that are brought to their attention	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9

SECTION C: Communication

How often do the following things happen in your unit/work area?

Think about your unit/work area:	Never ▼	Rarely ▼	Some- times ▼	Most of the time ▼	Always ▼	Does Not Apply or Don't Know ▼
1. We are informed about errors that happen in this unit	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
2. When errors happen in this unit, we discuss ways to prevent them from happening again ..	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
3. In this unit, we are informed about changes that are made based on event reports	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
4. In this unit, staff speak up if they see something that may negatively affect patient care	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
5. When staff in this unit see someone with more authority doing something unsafe for patients, they speak up	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
6. When staff in this unit speak up, those with more authority are open to their patient safety concerns	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9
7. In this unit, staff are afraid to ask questions when something does not seem right	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 9

SECTION D: Reporting Patient Safety Events

Think about your unit/work area:	Never ▼	Rarely ▼	Some- times ▼	Most of the time ▼	Always ▼	Does Not Apply or Don't Know ▼
1. When a mistake is <u>caught and corrected</u> <u>before reaching the patient</u> , how often is this reported?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
2. When a mistake reaches the patient and <u>could have harmed the patient, but did not</u> , how often is this reported?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
3. <u>In the past 12 months</u> , how many patient safety events have <u>you</u> reported?						
<input type="checkbox"/> a. None						
<input type="checkbox"/> b. 1 to 2						
<input type="checkbox"/> c. 3 to 5						
<input type="checkbox"/> d. 6 to 10						
<input type="checkbox"/> e. 11 or more						

SECTION E: Patient Safety Rating

1. How would you rate your unit/work area on patient safety?

Poor ▼	Fair ▼	Good ▼	Very Good ▼	Excellent ▼
<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

SECTION F: Your Hospital

How much do you agree or disagree with the following statements about your hospital?

Think about your hospital:	Strongly Disagree ▼	Disagree ▼	Neither Agree nor Disagree ▼	Agree ▼	Strongly Agree ▼	Does Not Apply or Don't Know ▼
1. The actions of hospital management show that patient safety is a top priority	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
2. Hospital management provides adequate resources to improve patient safety	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
3. Hospital management seems interested in patient safety only after an adverse event happens	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
4. When transferring patients from one unit to another, important information is often left out.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
5. During shift changes, important patient care information is often left out	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉
6. During shift changes, there is adequate time to exchange all key patient care information ...	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₉

Background Questions

1. How long have you worked in this hospital?

- a. Less than 1 year
- b. 1 to 5 years
- c. 6 to 10 years
- d. 11 or more years

2. In this hospital, how long have you worked in your current unit/work area?

- a. Less than 1 year
- b. 1 to 5 years
- c. 6 to 10 years
- d. 11 or more years

3. Typically, how many hours per week do you work in this hospital?

- a. Less than 30 hours per week
- b. 30 to 40 hours per week
- c. More than 40 hours per week

4. In your staff position, do you typically have direct interaction or contact with patients?

- a. YES, I typically have direct interaction or contact with patients
- b. NO, I typically do NOT have direct interaction or contact with patients

Your Comments

Please feel free to provide any comments about how things are done or could be done in your hospital that might affect patient safety.

Thank you for completing this survey.

APPENDIX I

COMPOSITE MEASURE QUESTIONS AND CRONBACH'S ALPHA

Teamwork

Section A, Question 1: In this unit, we work together as an effective team.

Section A Question 8. During busy times, staff in this unit help each other.

Section A Question 9. There is a problem with disrespectful behavior by those working in this unit. (negatively worded – will be reverse coded when calculating composite score)

Teamwork: Cronbach's alpha (3 items) = .76

Staffing and Work Pace

Section A Question 2. In this unit, we have enough staff to handle the workload.

Section A Question 3. Staff in this unit work longer hours than is best for patient care. (negatively worded – will be reverse coded when calculating composite score)

Section A Question 5. This unit relies too much on temporary, float, or PRN staff. (negatively worded – will be reverse coded when calculating composite score)

Section A Question 11. The work pace in this unit is so rushed that it negatively affects patient safety. (negatively worded – will be reverse coded when calculating composite score)

Staffing and Work Pace: Cronbach's alpha (4 items) = .67

Organizational Learning—Continuous Improvement

Section A Question 4. This unit regularly reviews work processes to determine if changes are needed to improve patient safety.

Section A Question 12. In this unit, changes to improve patient safety are evaluated to see how well they worked.

Section A Question 14. This unit lets the same patient safety problems keep happening. (negatively worded – will be reverse coded when calculating composite score)

Organizational Learning – Continuous Improvement: Cronbach's alpha (3 items) = .76

Response to Error

Section A Question 6. In this unit, staff feel like their mistakes are held against them. (negatively worded – will be reverse coded when calculating composite score)

Section A Question 7. When an event is reported in this unit, it feels like the person is being written up, not the problem. (negatively worded – will be reverse coded when calculating composite score)

Section A Question 10. When staff make errors, this unit focuses on learning rather than blaming individuals.

Section A Question 13. In this unit, there is a lack of support for staff involved in patient safety errors. (negatively worded – will be reverse coded when calculating composite score)

Reliability of this composite measure—Cronbach's alpha (4 items) = .83

Supervisor, Manager, or Clinical Leader Support for Patient Safety

Section B Question 1. My supervisor, manager, or clinical leader seriously considers staff suggestions for improving patient safety.

Section B Question 2. My supervisor, manager, or clinical leader wants us to work faster during busy times, even if it means taking shortcuts. (negatively worded – will be reverse coded when calculating composite score)

Section B Question 3. My supervisor, manager, or clinical leader takes action to address patient safety concerns that are brought to their attention.

Supervisor, Manager, or Clinical Leader Support for Patient Safety: Cronbach's alpha (3 items) = .77

Communication About Error

Section C Question 1. We are informed about errors that happen in this unit.

Section C Question 2. When errors happen in this unit, we discuss ways to prevent them from happening again.

Section C Question 3. In this unit, we are informed about changes that are made based on event reports.

Communication About Error: Cronbach's alpha (3 items) = .89

Communication Openness

Section C Question 4. In this unit, staff speak up if they see something that may negatively affect patient care.

Section C Question 5. When staff in this unit see someone with more authority doing something unsafe for patients, they speak up.

Section C Question 6. When staff in this unit speak up, those with more authority are open to their patient safety concerns.

Section C Question 7. In this unit, staff are afraid to ask questions when something does not seem right. (negatively worded – will be reverse coded when calculating composite score)

Communication Openness: Cronbach's alpha (4 items) = .83

Reporting Patient Safety Events

Section D Question 1. When a mistake is caught and corrected before reaching the patient, how often is this reported?

Section D Question 2. When a mistake reaches the patient and could have harmed the patient, but did not, how often is this reported?

Reporting Patient Safety Events: Cronbach's alpha (2 items) = .75

Hospital Management Support for Patient Safety

(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree, Does Not Apply or Don't Know)

Section F Question 1. The actions of hospital management show that patient safety is a top priority.

Section F Question 2. Hospital management provides adequate resources to improve patient safety.

Section F Question 3. Hospital management seems interested in patient safety only after an adverse event happens. (negatively worded – will be reverse coded when calculating composite score)

Hospital Management Support for Patient Safety: Cronbach's alpha (3 items) = .77

Handoffs and Information Exchange

Section F Question 4. When transferring patients from one unit to another, important information is often left out. (negatively worded – will be reverse coded when calculating composite score)

Section F Question 5. During shift changes, important patient care information is often left out. (negatively worded – will be reverse coded when calculating composite score)

Section F Question 6. During shift changes, there is adequate time to exchange all key patient care information.

Handoffs and Information Exchange: Cronbach's alpha (3 items) = .72

Other Questions:

Number of Events Reported

D3. In the past 12 months, how many patient safety events have you reported?

Patient Safety Rating. (Choices: None, 1 to 2, 3 to 5, 6 to 10, 11 or more)

E1. How would you rate your unit/work area on patient safety? (Choices: Poor, Fair, Good, Very Good, Excellent)

*Modified from SOPSTM Hospital Survey Items and Composite Measures (n.d.)

APPENDIX J

PRETESTING SEMI-STRUCTURED INTERVIEW QUESTIONS

The PI used the following questions to guide semi-structured interviews of participants:

1. How understandable do you feel this study was?
 - a. Was the consent statement clear? If not, what was confusing?
 - b. Was any of the language difficult to understand? If yes, what was difficult?
 - c. Was it challenging to understand any of the questions? If so, which ones?
 - i. Were there any questions you did not know how to answer or that you think others would not know how to answer? If so, which ones?
 - d. Were the answer choices appropriate for the questions? If not, which ones were not appropriate?
 - e. What changes could make this survey more understandable?
2. How did the survey flow? If it did not flow well, what issues did you have with the flow?
 - a. Were the questions logically ordered? If not, what did you feel was out of order?
 - b. Was the survey easy to navigate? If not, what difficulties did you have trying to navigate the survey?
 - c. What changes could make this survey flow better?
3. Did you have any technical issues when navigating through the survey? If so, what issues did you have?
4. Was the study challenging to take in any way? If so, what challenges did you have?
 - a. Did you ever feel like quitting the survey? If so, when did that happen?
 - b. Was the time that it took to take the survey appropriate?

When testing an updated version, if a participant has tested both versions, additional questioning is completed:

1. What differences did you notice in this updated survey?
 - a. How do you feel these changes improved or worsened your survey experience?

REFERENCES

- Agency for Healthcare Research and Quality, US Department of Health and Human Services. (2019, September 7). PSNet. *High reliability*. <https://psnet.ahrq.gov/primer/high-reliability>
- Agency for Healthcare Research and Quality. (2022, March). *What is patient safety culture?* <https://www.ahrq.gov/sops/about/patient-safety-culture.html#:~:text=Patient%20safety%20culture%20is%20the,influence%20their%20actions%20and%20behaviors>
- Aggarwal, R., & Ranganathan, P. (2019). Study designs: Part 2 - Descriptive studies. *Perspectives in Clinical Research, 10*(1), 34–36. https://doi.org/10.4103/picr.PICR_154_18
- Ahmed, A. H., Giri, J., Kashyap, R., Singh, B., Dong, Y., Kilickaya, O., Erwin, P. J., Murad, M. H., & Pickering, B. W. (2015). Outcome of adverse events and medical errors in the intensive care unit: A systematic review and meta-analysis. *American Journal of Medical Quality: The Official Journal of the American College of Medical Quality, 30*(1), 23–30. <https://doi.org/10.1177/1062860613514770>
- American Nurses Association. (2023, May 17). *How long does it take to become a nurse?* <https://www.nursingworld.org/content-hub/resources/becoming-a-nurse/how-long-does-it-take-to-become-a-nurse/>
- Angraini, N. D., Rivai, F., Pasinringi, S. A., Sidin, I., Hamzah, H., & Saleh, K. (2024). Influence of patient safety culture on medication administration error among nurses and midwives at Restu Ibu Hospital in Balikpapan, Indonesia. *Pakistan Journal of Life and Social Sciences, 22*(2), 15404–15415. <https://doi.org/10.57239/PJLSS-2024-22.2.001116>

- Armitage, G., & Knapman, H. (2003). Adverse events in drug administration: A literature review. *Journal of Nursing Management*, *11*, 130–140. <https://doi.org/10.1046/j.1365-2834.2003.00359.x>
- Assunção-Costa, L., de Sousa, I. C., Silva, R. K. R., do Vale, A. C., Pinto, C. R., Machado, J. F. F., Valli, C. G., & de Souza, L. E. P. F. (2022). Observational study on medication administration errors at a University Hospital in Brazil: Incidence, nature and associated factors. *Journal of Pharmaceutical Policy and Practice*, *15*(1), 51. <https://doi.org/10.1186/s40545-022-00443-x>
- Bagheri-Nesami, M., Esmaeili, R., & Tajari, M. (2015). Intravenous medication administration error and their causes in cardiac critical care units in Iran. *Materia Socio-Medica*, *27*, 442–446. <https://doi.org/10.5455/msm.2015.27.442-446>
- Barker, K. N., Flynn, E. A., Pepper, G. A., Bates, D. W., & Mikeal, R. L. (2002). Medication error observed in 36 health care facilities. *Archives of Internal Medicine*, *162*(16), 1897. <https://doi.org/10.1001/archinte.162.16.1897>
- Bastani, P., Barfar, E., Yusefi, A. R., Movahed, E., Dastyar, N., & Edirippulige, S. (2024). Medication errors and its relationship with patient safety culture: Evidence from nurses' viewpoint during COVID-19 pandemic. *Tanaffos*, *23*(2), 198–208. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11825077/>
- Berdot, S., Sabatier, B., Gillaizeau, F., Caruba, T., Prognon, P., & Durieux, P. (2012). Evaluation of drug administration error in a teaching hospital. *BMC Health Services Research*, *12*(1), 60–67. <https://doi:10.1186/1472-6963-12-60>
- Biftu, B. B., Dachew, B. A., Tiruneh, B. T., & Beshah, D. T. (2016). Medication administration error reporting and associated factors among nurses working at the University of Gondar

- referral hospital, Northwest Ethiopia, 2015. *BMC Nursing*, 15, 1.
<https://doi.org/10.1186/s12912-016-0165-3>
- Billstein-Leber, M., Carrillo, C. J. D., Cassano, A. T., Moline, K., & Robertson, J. J. (2018). ASHP guidelines on preventing medication error in hospitals. *American Journal of Health-System Pharmacy*, 75(19), 1493–1517. <https://doi.org/10.2146/ajhp170811>
- Blair, J., Czaja, R., & Blair, E. (2014). Questionnaire development iii: Pretesting. In J. Blair, R. Czaja, & E. Blair (Eds.), *Designing surveys: A guide to decisions and procedures* (3rd ed., pp. 252–276). Sage. <https://doi.org/10.4135/9781071909904>
- Blignaut, A. J., Coetzee, S. K., Klopper, H. C., & Ellis, S. M. (2017). Medication administration error and related deviations from safe practice: An observational study. *Journal of Clinical Nursing* 26(21–22), 3610. <https://doi.org/10.1111/jocn.13732>
- Bohomol, E., Ramos, L. H., & D’Innocenzo, M. (2009). Medication error in an intensive care unit. *Journal of Advanced Nursing*, 65(6), 1259–1267. <https://doi.org/10.1111/j.1365-2648.2009.04979.x>
- Burlison, J. D., Quillivan, R. R., Kath, L. M., Zhou, Y., Courtney, S. C., Cheng, C., & Hoffman, J. M. (2020). A multilevel analysis of U.S. hospital patient safety culture relationships with perceptions of voluntary event reporting. *Journal of Patient Safety*, 16(3), 187–193
<https://doi.org/10.1097/PTS.0000000000000336>
- Calabrese, A. D., Erstad, B. L., Brandl, K., Barletta, J. F., Kane, S. L., & Sherman, D. S. (2001). Medication administration error in adult patients in the ICU. *Intensive Care Medicine*, 27(10), 1592–1598. <https://doi.org/10.1007/s001340101065>

Carlson, M. D., & Morrison, R. S. (2009). Study design, precision, and validity in observational studies. *Journal of Palliative Medicine*, 12(1), 77–82.

<https://doi.org/10.1089/jpm.2008.9690>

Centers for Medicare & Medicaid Services. (2011, May 13). *SC-Letter-11-28*. U.S. Department of Health and Human Services. https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/downloads/scletter11_28.pdf

Centers for Medicare & Medicaid Services. (2023, March 9). *Revision to State Operations Manual (SOM), Hospital Appendix A - Interpretive Guidelines for 42 CFR 482.21, Quality Assessment & Performance Improvement (QAPI) Program* (Ref: QSO-23-09-Hospital). U.S. Department of Health & Human Services. <chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/https://www.cms.gov/files/document/qso-23-09-hospital.pdf>

Chassin, M. R. (2015). *High reliability in healthcare: Working toward zero harm*.

<http://arabhealthmagazine.com/press-releases/2015/issue-4/high-reliability-in-healthcareworking-toward-zero-harm/>

Choi, I., Lee, S.M., Flynn, L., Kim, C., Lee, S., Kim, N.K., & Suh, D.C. (2016). Incidence and treatment costs attributable to medication error in hospitalized patients. *Research in Social and Administrative Pharmacy*, 12(3), 428–437.

<https://doi.org/10.1016/j.sapharm.2015.08.006>

Cho, I., Park, H., Choi, Y. J., Hwang, M. H., & Bates, D. W. (2014). Understanding the nature of medication errors in an ICU with a computerized physician order entry system. *PLoS ONE*, 9(12), 1–15. <https://doi.org/10.1371/journal.pone.0114243>

- Chua, S. S., Chua, H. M., & Omar, A. (2009). Drug administration error in paediatric wards: A direct observation approach. *European Journal of Pediatrics*, *169*(5), 603–611.
<https://doi.org/10.1007/s00431-009-1084-z>
- Chua, S. S., Tea, M. H., & Rahman, M. H. A. (2009). An observational study of drug administration error in a Malaysian hospital (study of drug administration error). *Journal of Clinical Pharmacy & Therapeutics*, *34*(2), 215–223. <https://doi.org/10.1111/j.1365-2710.2008.00997.x>
- Churruca, K., Ellis, L. A., Pomare, C., Hogden, A., Bierbaum, M., Long, J. C., Olekalns, A., & Braithwaite, J. (2021). Dimensions of safety culture: a systematic review of quantitative, qualitative and mixed methods for assessing safety culture in hospitals. *BMJ open*, *11*(7), e043982. <https://doi.org/10.1136/bmjopen-2020-043982>
- Comachio, J., Poulsen, A., Bangboje-Ayodele, A., Tan, A., Ayre, J., Raeside, R., Roy, R., & O'Hagan, E. (2024). Identifying and counteracting fraudulent responses in online recruitment for health research: A scoping review. *BMJ Evidence-Based Medicine*. Advance online publication. <https://doi.org/10.1136/bmjebm-2024-113170>
- Conn, V. S., Valentine, J. C., Cooper, H. M., & Rantz, M. J. (2003). Grey literature in meta-analyses. *Nursing Research*, *52*(4), 256–261. <https://doi.org/10.1097/00006199-200307000-00008>
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.
- de Kok, K., van der Scheer, W., Ketelaars, C., & Leistikow, I. (2023). Organizational attributes that contribute to the learning & improvement capabilities of healthcare organizations: A

- scoping review. *BMC Health Services Research*, 23, 585. <https://doi.org/10.1186/s12913-023-09562-w>
- Duarte, S. da C. M., Queiroz, A. B. A., Büscher, A., & Stipp, M. A. C. (2015). Human error in daily intensive nursing care. *Revista Latino-Americana de Enfermagem*, 23(6), 1074–1081. <https://doi.org/10.1590/0104-1169.0479.2651>
- Endalamaw, A., Khatri, R. B., Mengistu, T. S., et al. (2024). A scoping review of continuous quality improvement in healthcare system: Conceptualization, models and tools, barriers and facilitators, and impact. *BMC Health Services Research*, 24, 487. <https://doi.org/10.1186/s12913-024-10828-0>
- Ernawati, D. K., Lee, Y. P., & Hughes, J. D. (2014). Nature and frequency of medication error in a geriatric ward: An Indonesian experience. *Therapeutics & Clinical Risk Management*, 10, 413–421. <https://doi.org/10.2147/TCRM.S61687>
- Evans, S. M., Berry, J. G., Smith, B. J., Esterman, A., Selim, P., O'Shaughnessy, J., & DeWit, M. (2006). Attitudes and barriers to incident reporting: A collaborative hospital study. *Quality & Safety in Health Care*, 15(1), 39–43. <https://doi.org/10.1136/qshc.2004.012559>
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175–191. <https://doi.org/10.3758/bf03193146>
- Feleke, S. A., Mulatu, M. A., & Yesmaw, Y. S. (2015). Medication administration error: Magnitude and associated factors among nurses in Ethiopia. *BMC Nursing*, 14, 1–8. <https://doi.org/10.1186/s12912-015-0099-1>

- Feleke, Y., & Girma, B. (2010). Medication administration error involving paediatric in-patients in a hospital in Ethiopia. *Tropical Journal of Pharmaceutical Research*, 9(4), 401–407. <https://doi.org/10.4314/tjpr.v9i4.58942>
- Fink, A. (2013). *How to conduct surveys: A step-by-step guide* (5th ed.). Sage.
- FitzHenry, F., Peterson, J. F., Arrieta, M., Waitman, L. R., Schildcrout, J. S., & Miller, R. A. (2007). Medication administration discrepancies persist despite electronic ordering. *Journal of the American Medical Informatics Association*, 14(6), 756–764. <https://doi.org/10.1197/jamia.M2359>
- Furnish, C., Wagner, S., Dangler, A., Schwarz, K., Trujillo, T., Stolpman, N., & May, S. (2021). Evaluation of medication administration timing: Are we meeting our goals? *Journal of Pharmacy Practice*, 34(5), 750–754. <https://doi.org/10.1177/0897190020905456>
- Garg, A. X., Hackam, D., & Tonelli, M. (2008). Systematic review and meta-analysis: When one study is just not enough. *Clinical Journal of the American Society of Nephrology: CJASN*, 3(1), 253–260. <https://doi.org/10.2215/CJN.0143030>
- Gauthier, A. K., Davis, K., & Schoenbaum, S. C. (2006). Commentary: Achieving a high-performance health system: High reliability organizations within a broader agenda. *Health Services Research*, 41(4 Pt 2), 1710–1720. <https://doi.org/10.1111/j.1475-6773.2006.00617.x>
- Gaw, M., Rosinia, F., & Diller, T. (2018). Quality and the health system: Becoming a high reliability organization. *Anesthesiology Clinics*, 36(2), 217–226. <https://doi.org/10.1016/j.anclin.2018.01.010>
- Giai, J., Boussat, B., Occelli, P., Gandon, G., Seigneurin, A., Michel, P., & François, P. (2017). Hospital survey on patient safety culture (HSOPS): variability of scoring

- strategies. *International Journal for Quality in Health Care*, 29(5), 685–692.
<https://doi.org/10.1093/intqhc/mzx086>
- Grober, E. D., & Bohnen, J. M. A. (2005). Defining medical error. *Canadian Journal of Surgery*, 48(1), 39–44. <https://www.canjsurg.ca/content/48/1/39.long>
- Gunningberg, L., Pöder, U., Donaldson, N., & Leo Swenne, C. (2014). Medication administration accuracy: Using clinical observation and review of patient records to assess safety and guide performance improvement. *Journal of Evaluation in Clinical Practice*, 20(4), 411–416. <https://doi.org/10.1111/jep.12150>
- Hammoudi, B. M., Ismaile, S., & Abu Yahya, O. (2018). Factors associated with medication administration error and why nurses fail to report them. *Scandinavian Journal of Caring Sciences*, 32(3), 1038–1046. <https://doi.org/10.1111/scs.12546>
- Harris, P. A., Taylor, R., Thielke, R., Payne, J. Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap): A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, 42(2), 377–381. <https://doi.org/10.1016/j.jbi.2008.08.010>
- Health Resources & Services Administration, Bureau of Health Workforce. (2022, August). *Detailed description of distribution of registered nurses by age*. U.S. Department of Health & Human Services. <https://bhw.hrsa.gov/data-research/access-data-tools/national-sample-survey-registered-nurses/detailed-description-rn-by-age>
- Hernandez, F., Majoul, E., Montes-Palacios, C., Antignac, M., Cherrier, B., Doursounian, L., Feron, J. M., Robert, C., Hejblum, G., Fernandez, C., & Hindlet, P. (2015). An observational study of the impact of a computerized physician order entry system on the rate of medication error in an orthopaedic surgery unit. *PloS One*, 10(7), e0134101.

- <https://doi.org/10.1371/journal.pone.0134101>
- Hicks, R. W., Cousins, D. D., & Williams, R. I. (2004). Selected medication-error data from USP's MEDMARX program for 2002. *American Journal of Health-System Pharmacy*, *61*(10), 993–1000. <https://doi.org/10.1093/ajhp/61.10.993>
- Hughes, R. G., & Blegen, M. A. (Eds.). (2008). Medication administration safety. In R.G. Hughes. *Patient safety and quality: An evidence-based handbook for nurses* (Chapter 37). Agency for Healthcare Research and Quality (US). <https://www.ncbi.nlm.nih.gov/books/NBK2656/>
- Hwang, J., & Ahn, J. (2015). Teamwork and clinical error reporting among nurses in Korean hospitals. *Asian Nursing Research*, *9*(1), 14–20. <https://doi.org/10.1016/j.anr.2014.09.002>
- IBM Corporation. (2020). *IBM SPSS Statistics for Windows, Version 27.0*.
- Idemoto, L. M., Williams, B. L., Ching, J. M., & Blackmore, C. C. (2015). Implementation of a custom alert to prevent medication-timing error associated with computerized prescriber order entry. *American Journal of Health-System Pharmacy*, *72*(17), 1481–1488. <https://doi.org/10.2146/ajhp140790>
- Institute for Safe Medication Practices. (2011). *ISMP acute care guidelines for timely administration of scheduled medications*; 2011. <https://www.ismp.org/sites/default/files/attachments/2018-02/tasm.pdf>
- Institute for Safe Medication Practices. (2018). *ISMP list of high-alert medications in acute care settings*. <https://www.ismp.org/sites/default/files/attachments/2018-08/highAlert2018-Acute-Final.pdf>

- James, J. T. (2013). A new, evidence-based estimate of patient harms associated with hospital care. *Journal of Patient Safety*, 9(3), 122.
<https://doi.org/10.1097/PTS.0b013e3182948a69>
- Jang, S. J., Lee, H., & Son, Y. J. (2021). Perceptions of patient safety culture and medication error reporting among early- and mid-career female nurses in South Korea. *International Journal of Environmental Research and Public Health*, 18(9), 4853.
<https://doi.org/10.3390/ijerph18094853>
- Kalisch, B. J., & Williams, R. A. (2009). Development and psychometric testing of a tool to measure missed nursing care. *The Journal of Nursing Administration*, 39(5), 211–219.
<https://doi.org/10.1097/NNA.0b013e3181a23cf5>
- Kaya, S., Banaz Goncuoglu, M., Mete, B., Asilkan, Z., Mete, A., Akturan, S., Tuncer, N., Yukselir Alasirt, F., Toka, O., Gunes, T., & Gumus, R. (2023). Patient safety culture: Effects on errors, incident reporting, and patient safety grade. *Journal of Patient Safety*, 19(7), 439–446. <https://doi.org/10.1097/PTS.0000000000001152>.
- Kelly, U., Edwards, G., & Shapiro, S. (2021). Nursing policies and protocols. *Journal of Nursing Care Quality*, 36(3), 217–222. <https://doi.org/10.1097/NCQ.0000000000000532>
- Keshtkar, L., Bennett-Weston, A., Khan, A. S., Mohan, S., Jones, M., Nockels, K., Gunn, S., Armstrong, N., Bostock, J., & Howick, J. (2025). Impacts of communication type and quality on patient safety incidents: A systematic review. *Annals of Internal Medicine*, 178(5), 687–700. <https://doi.org/10.7326/ANNALS-24-02904>
- Khalid, K., Abdullah, H. H., & Dileepkumar, M. (2012). Get along with quantitative research process. *International Journal of Research in Management*, 2(4), 15–29.

- Kohn, L. T., Corrigan, J., & Donaldson, M. S. (2000). *To err is human: Building a safer health system*. National Academy Press. <https://doi.org/10.17226/9728>
- Koppel, R., Wetterneck, T., Telles, J. L., & Karsh, B. T. (2008). Workarounds to barcode medication administration systems: Their occurrences, causes, and threats to patient safety. *Journal of the American Medical Informatics Association : JAMIA*, 15(4), 408–423. <https://doi.org/10.1197/jamia.M2616>
- Kruskal, W. H. (2012). Ordinal measures of association. *Journal of the American Statistical Association*, 53(284), 814–861. <https://doi.org/10.2307/2281954>
- Leufer, T., & Cleary-Holdforth, J. (2013). Let's do no harm: Medication errors in nursing: Part 1. *Nurse Education in Practice* 13, 213–216. <https://doi.org/10.1016/j.nepr.2013.01.013>
- Lisby, M., Nielsen, L. P., & Mainz, J. (2005). Error in the medication process: Frequency, type, and potential clinical consequences. *International Journal for Quality in Health Care*, 17(1), 15–22. <https://doi.org/10.1093/intqhc/mzi015>
- Loput, C. M., Saltsman, C. L., Rahm, R. C., Roberts, W. D., Sharma, S., Borum, C., & Casey, J. A. (2022). Evaluation of medication administration timing variance using information from a large health system's clinical data warehouse. *American Journal of Health-System Pharmacy: Official Journal of the American Society of Health-System Pharmacists*, 79(Suppl 1), S1–S7. <https://doi.org/10.1093/ajhp/zxab378>
- Lynch, S. S. (2022). *Drug efficacy and safety*. The Merck Manual of Diagnosis and Therapy. <https://www.merckmanuals.com/professional/clinical-pharmacology/concepts-in-pharmacotherapy/drug-efficacy-and-safety>
- Makary, M. A., & Daniel, M. (2016). Medical error: The third leading cause of death in the US. *BMJ*, 353, i2139. <https://doi.org/10.1136/bmj.i2139>

- Manias, E. (2013). Detection of medication-related problems in hospital practice: A review. *British Journal of Clinical Pharmacology*, 76(1), 7–20.
<https://doi.org/10.1111/bcp.12049>
- Metsälä, E., & Vaherkoski, U. (2014). Medication errors in elderly acute care: A systematic review. *Scandinavian Journal of Caring Science*, 28(1), 12–28.
<https://doi.org/10.1111/scs.12034>
- Mohammed, T., Mahmud, S., Gintamo, B., Mekuria, Z. N., & Gizaw, Z. (2022). Medication administration errors and associated factors among nurses in Addis Ababa federal hospitals, Ethiopia: A hospital-based cross-sectional study. *BMJ Open*, 12(12), e066531.
<https://doi.org/10.1136/bmjopen-2022-066531>
- Montesi, G., & Lechi, A. (2009). Prevention of medication errors: Detection and audit. *British Journal of Clinical Pharmacology*, 67(6), 651–655. <https://doi.org/10.1111/j.1365-2125.2009.03422.x>
- Morelock, S. G., & Kirk, J. D. (2019). An urban medical system's exploratory study of medication error. *Nursing Open*, 6(3), 1197–1204. <https://doi.org/10.1002/nop2.319>
- Munn, L. T., Lynn, M. R., Knafl, G. J., Willis, T. S., & Jones, C. B. (2023). A study of error reporting by nurses: The significant impact of nursing team dynamics. *Journal of research in nursing: JRN*, 28(5), 354–364. <https://doi.org/10.1177/17449871231194180>
- Nahm, F. S. (2016). Nonparametric statistical tests for the continuous data: The basic concept and the practical use. *Korean Journal of Anesthesiology*, 69(1), 8–14.
<https://doi.org/10.4097/kjae.2016.69.1.8>
- National Coordinating Council for Medication Error Reporting and Prevention. (2022). *About medication errors*. <https://www.nccmerp.org/about-medication->

- Paez, A. (2017). Gray literature: An important resource in systematic reviews. *Journal of Evidence-based Medicine*, 10(3), 233–240. <https://doi.org/10.1111/jebm.12266>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Aki, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372(71). <https://doi.org/10.1136/bmj.n71>
- Patel, T. K., Patel, P. B., Bhalla, H. L., & Kishore, S. (2022). Drug-related deaths among inpatients: A meta-analysis. *European Journal of Clinical Pharmacology*, 78(2), 267–278. <https://doi.org/10.1007/s00228-021-03214-w>
- Perneger, T. V., Courvoisier, D. S., Hudelson, P. M., & Gayet-Ageron, A. (2015). Sample size for pre-tests of questionnaires. *Quality of Life Research*, 24(1), 147–151. <https://doi.org/10.1007/s11136-014-0752-2>
- Polit, D. F., & Beck, C. T. (2022). *Essentials of nursing research: Appraising evidence for nursing practice* (10th ed.). Wolters Kluwer.
- Poon, E. G., Keohane, C. A., Yoon, C. S., Ditmore, M., Bane, A., Levtzion-Korach, O., Moniz, T., Rothschild, J. M., Kachalia, A. B., Hayes, J., Churchill, W. W., Lipsitz, S., Whittlemore, A. D., Bates, D. W., & Gandhi, T. K. (2010). Effect of bar-code technology on the safety of medication administration. *New England Journal of Medicine*, 362(18), 1698–1707. <https://doi.org/10.1056/NEJMsa0907115>

- Pullam, T., Russell, C. L., & White-Lewis, S. (2023). Frequency of medication administration timing error in hospitals: A systematic review. *Journal of Nursing Care Quality, 38*(2), 126–133. <http://doi.org/10.1097/NCQ.0000000000000668>
- Ramya, K. R., & Vineetha, R. (2014). Nurses' perception of medication error in South India. *Asian Journal of Nursing Education and Research, 4*(1), 20–25.
- Roberts., T. (2014). Understanding survey research: Application and processes. *British Journal of Midwifery, 20*, 114–120. <https://10.12968/bjom.2012.20.2.114>
- Rodwin, B. A., Bilan, V. P., Merchant, N. B., Steffens, C. G., Grimshaw, A. A., Bastian, L. A., & Gunderson, C. G. (2020). Rate of preventable mortality in hospitalized patients: A systematic review and meta-analysis. *Journal of General Internal Medicine, 35*(7), 2099–2106. <https://doi.org/10.1007/s11606-019-05592-5>
- Rosen, M. A., DiazGranados, D., Dietz, A. S., Benishek, L. E., Thompson, D., Pronovost, P. J., & Weaver, S. J. (2018). Teamwork in healthcare: Key discoveries enabling safer, high-quality care. *The American Psychologist, 73*(4), 433–450. <https://doi.org/10.1037/amp0000298>
- Roughhead, E. E., Semple, S. J., & Rosenfeld, E. (2016). The extent of medication errors and adverse drug reactions throughout the patient journey in acute care in Australia. *International Journal of Evidence-based Healthcare, 14*(3), 113–122. <https://doi.org/10.1097/XEB.0000000000000075>
- Roughhead, L, Semple, S, & Rosenfeld, E. (2013). *Literature review: Medication safety in Australia*. Australian Commission on Safety and Quality in Health Care, Sydney. <https://www.safetyandquality.gov.au/sites/default/files/migrated/Literature-Review-Medication-Safety-in-Australia-2013.pdf>

- Ruel, E., Wagner, W., & Gillespie, B. (2016). Pretesting and pilot testing. In *The practice of survey research: Theory and applications* (pp. 101–119). Sage.
<https://doi.org/10.4135/9781483391700>
- Rutledge, D. N., Retrosi, T., & Ostrowski, G. (2018). Barriers to medication error reporting among hospital nurses. *Journal of Clinical Nursing*, 27(9–10), 1941–1949.
<https://doi.org/10.1111/jocn.14335>
- Schuermann, A., Arkin, L., & Loerzel, V. (2024). An exploration of nurses' attitudes and beliefs on reporting medication errors. *Journal of Nursing Care Quality*, 39(3), 279–285.
<https://doi.org/10.1097/NCQ.0000000000000770>
- Scott, S. S., & Henneman, E. (2017). Professional issues. Underreporting of medical errors. *MEDSURG Nursing*, 26(3), 211–213. <https://www.proquest.com/scholarly-journals/underreporting-medical-errors/docview/1906914843/se-2>
- Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*, 61(3), 261–264. <https://doi.org/10.4103/0019-5154.182410>
- Sigma. (n.d.-a). *About Sigma*. Sigma Nursing. <https://www.sigmanursing.org/why-sigma/about-sigma>
- Sigma. (n.d.-b). *Member home*. <https://thecircle.sigmanursing.org/home/memberhome>
- Smiley, R. A., Allgeyer, R. L., Shobo, Y., Lyons, K. C., Letourneau, R., Zhong, E., Kaminski-Ozturk, N., & Alexander, M. (2023). The 2022 national nursing workforce survey. *Journal of Nursing Regulation*, 14(Suppl), s1–s90.
<https://www.journalofnursingregulation.com/action/showPdf?pii=S2155-8256%2823%2900047-9>

SOPSTM Hospital Survey Items and Composite Measures. (n.d.).

<https://www.ahrq.gov/sites/default/files/wysiwyg/sops/surveys/hospital/hospitalsurvey2-items.pdf>

Sorra, J. (n.d.). *AHRQ surveys on Patient Safety Culture™ Hospital Survey version 2.0*.

[Webcast]. Agency for Healthcare Research and Quality.

<https://www.ahrq.gov/sites/default/files/wysiwyg/sops/surveys/3-sorra-sops-hospital-survey-2-0-webcast.pdf>

Sorra, J., Yount, N., Famolaro, T., Gray, L., & Westat, R. (2019). *AHRQ Hospital Survey on Patient Safety Culture Version 2.0: User's Guide*. Agency for Healthcare Research and Quality. <https://www.ahrq.gov/sops/surveys/hospital/index.html>

Sorra, J., Yount, N., Famolaro, T., Gray, L., & Westat. (2021). *AHRQ Hospital Survey on Patient Safety Culture Version 2.0: User's guide*. Agency for Healthcare Research and Quality. <https://www.ahrq.gov/sops/surveys/hospital/index.html>

Soydemir, D., Seren Intepeler, S., & Mert, H. (2017). Barriers to medical error reporting for physicians and nurses. *Western Journal of Nursing Research*, 39(10), 1348–1363. <https://doi.org/10.1177/0193945916671934>

State Operations Manual – CMS. (2020). §482.23(c) Standard: Preparation and Administration of Drugs. https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/som107ap_a_hospitals.pdf

Stetina, P., Groves, M., & Pafford, L. (2005). Managing medication errors: A qualitative study. *MEDSURG Nursing*, 14(3), 174–178

Sunshine, J. E., Meo, N., Kassebaum, N. J., Collison, M. L., Mokdad, A. H., & Naghavi, M. (2019). Association of adverse effects of medical treatment with mortality in the United

- States: A secondary analysis of the Global Burden of Diseases, Injuries, and Risk Factors Study. *JAMA Network Open*, 2(1), e187041.
<https://doi.org/10.1001/jamanetworkopen.2018.7041>
- Sutcliffe, K. M. (2011). High reliability organizations (HROs). *Best Practice & Research Clinical Anaesthesiology*, 25(2), 133–144. <http://doi:10.1016/j.bpa.2011.03.001>
- Tabatabaee, S. S., Ghavami, V., Javan-Noughabi, J., & Kakemam, E. (2022). Occurrence and types of medication error and its associated factors in a reference teaching hospital in northeastern Iran: A retrospective study of medical records. *BMC Health Services Research*, 22(1), 1420. <https://doi.org/10.1186/s12913-022-08864-9>
- Tariq, R. A, Vashisht, R., Sinha, A., & Scherbak, Y. (2021). *Medication dispensing errors and prevention*. StatPearls Publishing. Available from: StatPearls [Internet].
<https://www.ncbi.nlm.nih.gov/books/NBK519065/>
- Taufiq, S. (2015). Prevalence and causes of wrong time medication administration error: Experience at a tertiary care hospital in Pakistan. *Canadian Journal of Nursing Informatics*, 10(1). <https://www.proquest.com/scholarly-journals/prevalence-causes-wrong-time-medication/docview/2308260547/se-2>
- Tissot, E., Cornette, C., Demoly, P., Jacquet, M., Barale, F., & Capellier, G. (1999). Medication error at the administration stage in an intensive care unit. *Intensive Care Medicine*, 25(4), 353–359. <https://doi.org/10.1007/s001340050857>
- Tolley, C. L., Watson, N. W., Heed, A., Einbeck, J., Medows, S., Wood, L., Campbell, L., & Slight, S. P. (2022). The impact of a novel medication scanner on administration errors in the hospital setting: A before and after feasibility study. *BMC Medical Informatics and Decision Making*, 22(1), 86. <https://doi.org/10.1186/s12911-022-01828-3>

- Tsegaye, D., Alem, G., Tessema, Z., & Alebachew, W. (2020). Medication administration error and associated factors among nurses. *International Journal of General Medicine*, *13*, 1621–1632. <https://doi.org/10.2147/IJGM.S289452>
- Valdez, D., & Goodson, P. (2020). Language bias in health research: External factors that influence latent language patterns. *Frontiers in Research Metrics and Analytics*, *5*, 4. <https://doi.org/10.3389/frma.2020.00004>
- van den Bemt, P. M. L. A., Fijn, R., van der Voort, P. H. J., Gossen, A. A., Egberts, T. C. G., & Brouwers, J. R. B. J. (2002). Frequency and determinants of drug administration error in the intensive care unit. *Critical Care Medicine*, *30*(4), 846–850. <https://doi.org/10.1097/00003246-200204000-00022>
- Veazie, S., Peterson, K., & Bourne, D. (2019). *Evidence brief: Implementation of high reliability organization principles*. Department of Veterans Affairs (US). <https://www.ncbi.nlm.nih.gov/books/NBK542883/>
- von Ahn, L., Blum, M., Hopper, N. J., & Langford, J. (2003). CAPTCHA: Using hard AI problems for security. In R. Canetti (Ed.), *Advances in cryptology—EUROCRYPT 2003* (pp. 294–311). Springer. https://doi.org/10.1007/3-540-39200-9_18
- von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & STROBE Initiative (2008). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Journal of Clinical Epidemiology*, *61*(4), 344–349. <https://doi.org/10.1016/j.jclinepi.2007.11.008>
- Wawersik, D.M., Boutin Jr., E. R. ,Gore, T., Palaganas, J.C. (2023). Individual characteristics that promote or prevent psychological safety and error reporting in healthcare: A

- systematic review. *Journal of Healthcare Leadership*, 2023(15), 59–70.
<https://doi.org/10.2147/JHL.S369242>
- Weick, K., & Sutcliffe, K. (2015). *Managing the unexpected: Sustained performance in a complex world* (3rd ed.). John Wiley & Sons.
- Weick, K., Sutcliffe, K., & Obstfeld, D. (2000a). High reliability: The power of mindfulness. *Leader to Leader*, 2000(17), 33–38.
- Weick, K., Sutcliffe, K., & Obstfeld, D. (2000b). Organizing for high reliability: Processes of collective mindfulness. In R. S. Sutton & B. M. Staw (Eds.), *Research in organizational behavior* (pp. 81–123). Jai Press.
- Welton, J. M., Kleiner, C., Valdez, C., Richardson, S., Boyle, K., & Lucas, E. (2018). Using time-referenced data to assess medication administration performance and quality. *JONA: The Journal of Nursing Administration*, 48(2), 100–106.
<https://doi.org/10.1097/NNA.0000000000000580>
- Westbrook, J. I. (2010). Association of interruptions with an increased risk and severity of medication administration error. *Archives of Internal Medicine*, 170(8), 683.
<https://doi.org/10.1001/archinternmed.2010.65>
- Wondmienenh, A., Alemu, W., Tadele, N., & Demis, A. (2020). Medication administration error and contributing factors among nurses: A cross sectional study in tertiary hospitals, Addis Ababa, Ethiopia. *BMC Nursing*, 19(1), 1–9. <https://doi.org/10.1186/s12912-020-0397-0>
- World Health Organization (2023). *Patient safety*. <https://www.who.int/news-room/fact-sheets/detail/patient-safety>

VITA

Trinity Pullam completed her secondary education in Dexter, Missouri. She attended the University of Southeast Missouri in Cape Girardeau, Missouri, and was awarded a B.S. in Nursing in 2002. She returned to academics and earned a Master of Science in Nursing Education from the University of Central Missouri at Warrensburg, Missouri, in 2016.

In addition to academics, Ms. Pullam has practiced as a registered nurse for over 20 years. She spent the first 12 years of her nursing career at the local hospital in Dexter, Missouri, where she gained experience in medical-surgical and surgical nursing and later worked in management positions in case management, nursing informatics, and infection control. She began her nursing academic career in 2014 at Three Rivers College in Poplar Bluff, Missouri. She has been a tenured associate professor at Arkansas State University in Jonesboro, Arkansas, since 2019.

Ms. Pullam entered the University of Missouri-Kansas City Nursing Ph.D. program to gain research expertise and to explore her passion for patient care quality. Because of her history in acute care, she is particularly interested in focusing on hospital systems and identifying areas for improvement. Upon completion of her Doctor of Philosophy degree, Ms. Pullam plans to continue her academic career and pursue research opportunities related to nursing care in acute care and nursing education.