THE IMPACT OF INTRODUCING BEDSIDE MEDICATION VERIFICATION ON THE INCIDENCE OF MEDICATION ADMINISTRATION ERRORS

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Presented
to the Faculty of
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in
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by

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Summer 2014
THE IMPACT OF INTRODUCING BEDSIDE MEDICATION VERIFICATION ON THE INCIDENCE OF MEDICATION ADMINISTRATION ERRORS

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Amber P. Genato

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APPROVED BY THE DEAN OF GRADUATE STUDIES AND VICE PROVOST FOR RESEARCH:

E. K. Park, Ph.D.

APPROVED BY THE GRADUATE ADVISORY COMMITTEE:

Jennifer Lillibridge, Ph.D.
Graduate Coordinator

Margaret Rowberg, D.N.P.

Mohammad Asia, Ph.D.
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ABSTRACT

THE IMPACT OF INTRODUCING BEDSIDE MEDICATION VERIFICATION ON THE INCIDENCE OF MEDICATION ADMINISTRATION ERRORS

by

© Amber P. Genato 2014

Master of Science in Nursing

California State University, Chico

Summer 2014

The administration of medication in an acute care setting is a fundamental role of a registered nurse and is the last step in the medication process. In 1999, the Institute of Medicine published a hallmark report; *To Err is Human*, which exposed the significance of preventable medical errors in U.S. hospitals across the country. The findings of this report promoted the demand for improvements in the delivery and safety of healthcare.

The healthcare industry has begun to turn attention to the utilization of technology to promote the delivery of safe care. This study looked at whether the technology, bedside medication verification (BMV), had an impact on medication administration error (MAE) rates comparing errors prior to and after the implementation of the technology. BMV is a technology that allows the nurse to scan a medication, which
is linked to an individual’s electronic medication administration record, and then scan a patient specific barcode worn by the patient. This technology has the capability to alert the nurse that the medication scanned is for the correct person, at the correct dose, time, and route.

The results from this study showed a decrease in the total number of reported MAE (122 pre- compared to 68 post-) following the implementation of BMV in an acute care setting. More significant was the decrease in errors per patient day following the implementation of BMV, 9.2 to 4.8. While results from this study are promising that the implementation of BMV decreases overall error rates, the results did observe an increase in wrong dosing (pre- n=14 or 11.5% compared to post- n=22 or 32.3%) and wrong drug (Pre- n=4 or 4.1% compared to post- n=4 or 5.9%). The findings from this study suggest that the implementation of BMV/EMR, during medication administration, can decrease the overall number of medication administration errors.
CHAPTER I

INTRODUCTION

The Institute of Medicine (IOM) published a hallmark report in 1999, *To Err is Human*, which detailed the significance of preventable medical errors in America’s healthcare institutions. In 2007, the IOM published another significant report, *Preventing Medication Errors: Quality Chasm Series*. These reports estimated that a hospitalized patient is subject to one medication administration error each day. In classic works by Bates et al. (1995b) and Leape, Bates, Cullen, Cooper, and Demonaco (1995) and substantiated in more recent studies (ECRI Institute, 2012; Kopp, Erstad, Allen, Theodorou, & Priestley, 2006), medication errors can occur at each stage of the medication process, but those errors that occur during medication administration are less likely to be detected and more likely to reach the patient. While preventable and potential adverse medication errors can occur during the ordering, processing, and administration phase, 16.7% to 34% of errors occur during the administration phase (Kopp, Erstad, Allen, Theodorou, & Priestley, 2006; Poon et al., 2010). In a more recent study, Berdot et al. (2012) observed a medication administration error rate, in a teaching hospital, of 27.6%; thus confirming that medication administration remains error prone. Hughes and Bregen (2008) warn that despite medication administration error research, it is difficult to assess the true prevalence of errors, noting that many errors cause no harm and go undetected.
Background

Medical errors occur at an alarming rate in America’s healthcare institutions. The IOM (1999) report, *To Err is Human*, was the first report of its kind to expose the significance of preventable medical errors. This report caught the attention of healthcare providers, advocates, policy makers, and patients, each of whom demanded improvements in the delivery and safety of healthcare. Despite the IOM’s candid report published over a decade ago, little change has been made in the healthcare industry to decrease medical errors (Landrig, et al., 2010; Safe Patient Project, 2009).

The administration of medication in an acute care setting is a fundamental role of a registered nurse and is the last step in the medication process preceded by the initiation and processing of the order (Agyemang & While, 2010). It has been estimated that 19% to 26% of a nurse’s time is spent administering medications utilizing the 5 rights to medication administration to prevent errors (right patient, time, dose, route, or drug) (Keohan et al., 2008; Westbrook, Duffield, Li, & Creswick, 2011). Yet, in recent studies, researchers report medication administration error rates of 16.7% to 27.6% (Berdot et al., 2012; DeYoung, Vanderkooi, & Barletta, 2009; Poon et al., 2010). These findings further place an emphasis on the need for safe medication administration in nursing practice.

In 2007, the IOM published *Preventing Medication Errors: Quality Chasm Series*. This report aimed to provide recommendations and guidance to organizations on medication error prevention strategies. Suggested in the IOM report and supported by the Agency for Healthcare and Research Quality (AHRQ, 2005) was bedside medication verification (BMV). BMV is bar coding technology that is used prior to the
administration of medications to confirm patient identity and ordered medication with the goal of preventing medication administration errors (MEDITECH, n.d.). Bar scanning technology was believed to have the potential to reduce the frequency of medication errors during the time of medication administration. Since the publication of the IOM and AHRQ reports, the implementation of bar scanning technology during medication administration has become widely supported by the National Coordinating Council for Medication Error Reporting and Prevention, the Massachusetts Coalition for the prevention of Medical Errors, Performance Monitoring system, and the Agency for Healthcare Research and Quality (National Research Council [NRC], 2007).

Hospitals are turning to technology as a means to improve safety during medication administration through the use of barcode medication verification at the bedside and electronic medication records (BMV/EMR) to improve patient safety and reduce the risk of medication administration errors. While several research studies have demonstrated successful reductions (27.3% to 58%) in medication administration errors through the implementation of these methods, further research is needed to evaluate the effectiveness of BMV/EMR in reducing system related errors (Helmons, Wargel, & Daniels, 2009; Franklin, O'Grady, Donyai, Jacklin, & Barber, 2007; Paoletti et al., 2007; Poon et al., 2010).

In a recent report published by the Patient Safety and Quality Healthcare (PSQH, 2012), it was estimated that approximately 46% of United States hospitals had implemented bar scanning technology. The PSQH further stated that the majority of the hospitals that had implemented bar scanning technology were primarily academic medical centers and health systems. This research study evaluated the impact of BMV
technology in a rural stand-alone healthcare facility which will add to the limited number of published studies that display the impact that BMV had on medication administration errors in this care setting.

**Statement of the Problem**

The delivery of medication remains an essential task for nurses and is the final step in the medication process. Keohane et al. (2008) found that a nurse will spend 25% of his or her day in medication administration. On average, a patient will receive 6 medications during a scheduled medication administration time (Grigg, Garret, & Craig, 2011). Despite the safety checks that occur during the initiation, processing, and administration of an order, errors (wrong patient, time, dose, route, or drug) still occur at the administration process (Helmons, Wargel, & Daniels, 2009).

The use of bedside medication verification technology or bar scanning has shown promising results in decreasing the incidence of medication administration errors by 41.1 to 54% (Paoletti et al., 2007; & Poon et al., 2010). Additionally, Paoletti et al (2007) observed a 50.8% decrease in potential adverse drug events through the implementation of this technology.

This study aimed to measure the dependent variable of medication administration errors after the implementation of BMV. While the implementation of BMV was the intervention, the results from this study were impacted by a number of confounding variables such as: the training of the nursing staff on the system, number of medications each patient is administered, the acuity of patients, nurse to patient ratio,
length of time in the nursing profession, and the error reporting practices of the staff. The independent variables were not analyzed in this study.

The use of technology to assist care providers in reducing errors during the administration phase of the medication process has shown results favoring the improvement in patient safety and decreasing preventable medication errors. Despite the promising results, both the AHRQ (2005) and NRC (2007) supported the need for additional research in this area of technology. While the recommendations from the AHRQ and NRC are dated, they illustrate the need for additional research at a national level. The rationale for this study was to add to the limited volume of studies that display the results of the impact that BMV has on medication administration error rates.

Relevance/Importance of the Study

Medication administration is the final step in the medication process and is often carried out by a registered nurse (Agyemang & While, 2010). LaDuke (2009) found that 26-38% of errors occur during administration while 34-39% of errors occur at the initiation of a medication order (Al-Shara, 2011; Lisby, Nielsen, and Mainz, 2005). Despite the number of medication errors that occur at every stage of the medication process, Picone, Titler and Dochterman (2008) found that 96% of errors could be prevented. The complexity of medication administration and the factors that cause errors have been studied extensively (Armitage & Knapman, 2003; Baker, 1997; Bruce & Wong, 2001; Lasseter & Warnick, 2003; Mahmood, Chaudhury, & Valente, 2011; Mayo & Duncan, 2004; O’Shea, 1999; Pape et al., 2005; Polifroni, McNulty, & Allchin, 2003; & Tissot et al., 2003). These studies concluded that medication administration errors,
while the majority are human factor related, are caused by a variety of reasons including but not limited to: illegible physician writing, distraction by patients, co-workers, or other activities occurring on the unit, insufficient patient monitoring, poor medical supply organization, department acoustics, poor lighting, lack of privacy, fear of retribution, lack of consistent definition of medication error, lack of drug and clinical knowledge, drug calculation deficits, and drug preparation deficits.

The nursing profession has used the ‘five rights’ of medication administration (right medication, right dose, right route, right time, and right patient) for decades to lessen the occurrence of preventable medication administration errors. In a recently published study, the researchers found that the adherence rate to these guidelines may be low suggesting that the ‘five rights’ are not strictly followed (Kim & Bates, 2012). Despite the safety steps that are in place, medication administration remains one of the highest risk areas in nursing practice next to the treatment and care management of a patient (Nurses Service Organization, 2009) and accounts for 19% to 26% of a nurse’s day (Keohan et al., 2008; Westbrook, Duffield, Li, & Creswick, 2011).

Since nurses will continue to administer medications, the issues surrounding patient safety should expand. Eliminating the factors that contribute to medication errors will likely never cease however, advances in technology, such as BMV and bar scanning technology that improve patient safety and the delivery of care, are emerging. BMV will enhance nursing practice and patient safety by ensuring the medication that is being administered will be given to the correct patient at the right dose, time, and route, while prompting the nurse to review clinical data for drug appropriateness.
Theoretical Framework

Rogers’ (2003) Diffusion of Innovation (DOI) theory provided the framework for this study. Rogers’ DOI was an appropriate theory for this study as it provided a framework for evaluating the steps of technology implementation. For the purposes of this study, only the adoption phase of DOI was studied. DOI guided this study by evaluating what effects or consequences the implementation of BMV/EMR had on medication administration errors at the study organization. The DOI consists of five stages divided into three phases (Figure 1):

**Figure 1.** Rogers’ Diffusion of Innovation theoretical framework.

The first phase of the DOI is initiation. The initiation phase consists of two distinct stages, agenda-setting and matching (Rogers, 2003). Agenda-setting is better defined as the decision to explore various solutions when a general problem is identified and defined. In most organizations, the agenda-setting stage is always occurring and
initiatives are acted upon through prioritization (Rogers, 2003). The second stage in the
initiation phase of DOI is matching. Matching involves aligning the innovation, or in this
case, the technology, to the identified problem of medication errors (Rogers, 2003).
During this stage, the technology is explored in depth to determine whether to accept or
reject the innovation. The analysis includes exploring the benefits, problems, feasibility,
and costs to initiate and sustain the technology. Innovation matching can be completed
through the research of others.

The second phase in DOI is implementation. The implementation phase marks
the work completed in the first stage of DOI. The implementation phase consists of three
stages; redefining/restructuring, clarifying, and routinizing (Rogers, 2003). The first stage
in phase two, redefining/restructuring, occurs when the innovation is personalized to the
organization’s needs and goals (Rogers, 2003). Clarifying is the second stage of
implementation. Clarifying “occurs as the innovation is put into more widespread use in
an organization, so that the meaning of the new idea gradually becomes clearer to the
organization’s members” (Rogers, 2003, p. 427). The third and final stage in the
implementation phase is routinizing. Routinizing occurs when the technology is
incorporated into the regular activities of the organization and has lost its separate
identity.

According to Rogers (2003), past research studies using the Diffusion of
Innovation theory have focused on the innovation as the main dependent variable. Rogers
argues that the ultimate dependent variable should be the consequences of the innovation,
which has gained little attention in research studies. Consequences are the final stage in
the DOI theory. The consequences, both positive and negative will be examined in this study.

Rogers (2003) defined consequences as the “changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation” (p. 436). The focus of this study was to examine the consequences of the innovation, BMV/EMR, in the taxonomy described as anticipated versus unanticipated consequences. Rogers (2003) describes this taxonomy as a useful dimension in examining the indirect consequences that occur as a result of the innovation. Rogers defined unanticipated consequences as “changes due to an innovation that are neither intended nor recognized by the members of a social system” (p. 448) and are unknown at the time of technology adoption. In examining the consequences of BMV/EMR technology, this can be applied by examining the emergence of new medication administration type errors that are a direct result of the technology.

Previous research using the DOI theory has focused on the initiation and implementation stages of innovation (Rogers, 2003). This study was guided using the final stage in the DOI theory, consequences, to evaluate the effect that BMV/EMR had on medication administration errors in nursing practice.

Purpose/Aims of the Study

The purpose of this study was to add to the body of knowledge about the effects of technology in the delivery of care. In particular, this study evaluated whether the implementation of the technology, bedside medication verification, influenced the safety of medication administration based upon the precept found within the DOI theory.
The study aimed to evaluate the number and incidence of medication administration errors pre and post implementation of bedside medication verification by analyzing the aggregated self-reported medication administration errors at a 250 bed acute care hospital in rural California.

Research Question

The study assessed the incidence of medication errors that occurred three months prior to the implementation of bedside medication verification and three months after the implementation of bedside medication verification in an acute care setting. The research question for this study was:

What was the impact of the implementation of bedside medication verification technology on the incidence of medication errors during a three month period pre- and post-implementation of this technology at an acute care facility in northern California?

Definition of Terms

- Medication Administration- The act of administering a medication to a patient as prescribed. Medication administration involves assessing the client, making clinical decisions and planning care based on the assessment (Saskatchewan Registered Nurses’ Association, 2007)

- Medication Error- “A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer” (National Coordinating Council for Medication Error Reporting and Prevention [NCCMERP], 2012, ¶1).
• Bar Coding Technology – “A graphic representation of data (alpha, numeric, or both) that is machine-readable” (Healthcare Information and Management Systems Society [HIMSS], 2003).

• Bedside Medication Verification – Bar coding technology that is used prior to the administration of medications to confirm patient identity and ordered medication (MEDITECH, n.d.)

Qualification of Researcher

The researcher in this study is a Master of Science in Nursing Student at a large public university system in California. The researcher has been a registered nurse for eight years working in a variety of departments. The researcher has provided care and leadership in a medical-surgical unit, Patient Service Excellence Department, Hospitalist Program, and the Quality Management Department. The researcher holds a certification in Medical-Surgical Nursing (CMSRN).

The researcher currently works under the umbrella of the Quality Management Department and serves as quality resource in various organizational initiatives. The researcher currently serves as a nurse leader and quality management resource in the study organization medication reconciliation initiative which aimed to reduce errors associated with inaccurate medication reconciliation.

Transitional Statement

Chapter one has reviewed the background for this study and its importance in nursing practice. A research question was posed for this study to evaluate whether the study site experienced a change in medication administration errors three months post
bedside medication verification implementation as compared with the previous three months. The study will be guided using Rogers’ theoretical framework, Diffusion of Innovations.

Chapter two examines the literature related to this thesis topic. The literature review evaluates literature specific to medication errors, medication administration errors, reporting of medication administration errors in nursing practice, and the effects of information technology, specifically bar code scanning, in medication administration. Chapter two describes the gaps in current research related to the effects of bar code scanning in medication administration.
CHAPTER II

LITERATURE REVIEW

Chapter two examined the current literature surrounding medication administration. This chapter was broken into three sections. Section one evaluated the incidence of medication administration errors in several acute care settings. Section two evaluated the reporting practices, the interruptions nurses experienced during the medication administration, and nurse perceptions of what constituted a medication administration error. Finally, section three examined the current literature on the impact of bedside medication verification in the acute care setting.

CINAHL Plus was the main database searched for this study. Other search engines utilized for conducting the literature review included Academic Search, PubMed, MEDLINE, Wiley Online Library, Cochrane, and Google. The search terms: medical errors, barcode scanning, bedside medication verification, medication errors, and nurse were used with the Boolean operator “AND” along with the words - incidence, reporting, perception, and implementation. Each article abstract was reviewed and determined whether the research was appropriate for this study. Additional articles were identified from the reference list of pertinent articles and were also reviewed.
Medication Administration Errors

In an original investigation study conducted by Barker, Flynn, Pepper, Bates, and Mikeal (2002), direct observation was used as a means to identify the specific types of medication errors that occur during the time of medication administration. The study was conducted at 36 sites in Atlanta and Denver during the time period, May 4 through November 11, 1999. One research assistant observed the preparation and administration of each medication, documenting each action taken by the nurse. The observation details, which included medication dose, time, indications, patient symptoms, and route, were documented and independently reviewed by a licensed pharmacist to determine whether a medication administration error occurred. The study concluded that of the 3,216 observed medications administrations, 605 (95% CI ±4.5%) medication errors were identified. The most frequent errors included wrong time (43%), medication omission (30%), wrong dose (30%) and unauthorized drug (4%). This study further concluded that medication errors occur in one out of five medication doses. The results from this study should be viewed with caution. The first limitation in this study is that participants were randomly selected and could decline to participate in the study. A participant’s decision to decline participation in the study could decrease the chance that the study results are representative of the actual practice of nurses thus affecting the results of the study. The second limitation is that medication administration observation was based on the convenience sample methodology. Finally, the presence of an observation must be considered as a limitation to the study as standard practices may have been altered by the participants. While this study was conducted over a decade ago, the results are
representative of medication administration error rates without the utilization of technology.

In a more recent study focusing specifically on the pediatric population, Otero, Leyton, Mariani, Ceriani Cernades, and the Patient Safety Committee (2008) conducted a pre- and post-interventional cross-section study evaluating the incidence of medication errors. The researchers conducted a chart review that evaluated 590 written prescriptions and 1174 medication administrations for 95 patients. Two researchers reviewed each of the 95 charts to determine whether an error had occurred. Disputes between the researchers were given to an independent reviewer. The authors concluded that the prescription error rate was 17.3% (102/590) and the medication administration error rate was 8.4% (99/1174). The most frequent medication administration error was drug omission (47/99; 47%). Prescription errors occurred one time for every five to six orders. The authors observed no patient harm during the study as a result of a medication error. The study results should be viewed with caution as it was conducted at one hospital in Argentina and data abstraction was not blinded. Additionally, the study was conducted through chart reviews, which did not allow the researchers to ask questions at the time of the error.

Westbrook, Woods, Rob, Dunsmuir, and Day (2010) conducted a direct observational study examining medication administration in two acute care hospitals in Sydney, Australia. The observations were completed by three researchers, each having been trained using the study observational tool and in the use of the personal digital assistant for data collection. Inter-rater reliability was achieved prior to the commencement of the study. The researchers observed 5,950 (4,271 in hospital A; 1,679
in hospital B) medication administrations for 926 (720 in hospital A; 206 in hospital B) patients. Each error was categorized either as a procedural (failure to read medication labels, check patient identification, confirm to check clinical indicators for administration, double check high risk drugs, and improper preparation and administration techniques) or clinical errors (wrong time, dose, route, drug, or strength). The authors concluded that 74.4% \((n=3177)\) of all medication administrations had a procedural failure and 25% \((n=1067)\) had a clinical failure. Failure to check a patient’s identification accounted for 58.7% (CI 95%) of all procedural errors while timing failures accounted for 16.1% (CI 95%) of clinical errors. While wrong drug errors accounted for only 0.3 % \((n=13)\) of clinical errors, the researchers classified 46.2% of the errors as either having an actual or potential to cause permanent reduction in bodily function or major permanent damage to the patient. The results from the study should be considered with some caution. The study was conducted in Australia and was limited to two hospital settings, none of which were critical care making the results non-applicable to all nursing care areas. Additionally, the study excluded weekends and nights thus the applicability for work during these shifts is unknown.

Berdot et al. (2012) aimed to determine the medication administration error rate in the adult population in the acute care setting. The authors conducted a disguised observation study using one trained research observer for data collection. The research assistant observed twenty-eight nurses prepare and administer a total of 1501 routine medications. The researchers concluded that of the 1501 medications administered, 415 (27.6%) administration errors occurred at least once but a total of 430 errors were identified. The researchers found that 13 medication administrations had two errors while
one administration had 3 errors (total errors were 430). Expanding on the findings, 312 (72.6%) of the errors were timing errors while 118 (7.8%) were non-timing errors. Error of drug omission \( (n=60; 14.0\%) \) and unauthorized drug errors \( (n=16; 3.7\%) \) were found to be most common errors following timing errors. While this study does demonstrate that medication administration errors remain prevalent in the acute care setting, the study does pose some limitations. The study was conducted in France at a single study site. Some critics can argue that staffing ratios are considerably different from that of the United States, though the average number of patients for which the study participants cared was eight. The study excluded the observation of as needed medications. Finally, the study excluded Sundays from the study.

The above studies demonstrate the current knowledge surrounding medication administration errors. Medication administration error rates occur at staggering rates. These studies represent the frequency of medication administration errors in the acute care setting when technology is not incorporated into the nursing workflow. The studies above demonstrate that errors occur at a rate of 8.4% \( (Otero \ et \ al., \ 2008) \) to 27.6% \( (Berdot \ et \ al., \ 2012) \) and in all acute care settings. The next section aims to review the current literature on adherence to medication administration safety and nursing reporting.

Potential Causes and Reporting of Errors

Five Rights

The National Coordinating Council for Medication Error Reporting and Prevention [NCC MERP] (2010) was founded in 1995 under the direction of the United States Pharmacopeia (USP). The NCC MERP is an independent body comprised of
fifteen interdisciplinary organizations and agencies with the purpose of “mounting a nationwide campaign for medication error reporting and prevention” (p.3). Specific to the practice of medication administration in nursing practice, the Council, in 1999, adopted recommendations, which focused on the five patient rights (right patient, drug, route, time, and dose). The recommendation called for the implementation of three label checks prior to medication administration and continuous patient monitoring for medication effects (NCC MERP).

Kim and Bates (2013) conducted an observational study in an effort to evaluate the adherence to the five rights of medication administration in nursing practice. The study sample was selected through a convenience sampling approach and the study was conducted using observation methodology. A total of 293 medication administrations were observed by six trained observers. The study concluded that only 6.5% \( (n=19) \) of the time, nurses read the wristband worn by the patient and 3.4% \( (n=10) \) of the nurses asked the patient his or her name. The researchers observed that 41% \( (n=120) \) of the time, medications were administered on time and 45.6% \( (n=93) \) of the time, the nurse correctly verified syringe medication doses by reading the markings at eye level. The results from this study raise the question as to whether the five rights of medication administration are common practice in the workflow of nurses during medication administration. The results of this study should be viewed with caution. The study was conducted in Korea where regulatory requirements vary from that of the United States. Additionally, the sampling for the study was limited to two wards of the study hospital and may not be representative of the practice of nurses at large.
Perception of Medication Error

This section will illustrate that errors are reported (hopefully) when an individual believes a mistake had been made. The incidence of medication errors in acute care settings are typically identified by the healthcare staff that report the error and are reported voluntarily (Wakefield, Wakefield, Uden-Holman, & Blegen, 1996). This type of reporting system has led to variability in identifying the true incidence of medication errors; thus limiting the use of root cause analysis to prevent future errors (Chiang, Li, Hsu, & Ma, 2010; Wakefield, Wakefield, Uden-Holman, & Blegen, 1996). Mrayan (2012) concluded that what constitutes an error is not consistent hence, errors are under reported.

In an attempt to understand nurses’ perceptions related to what constitutes a reportable medication incident report, Mrayyan (2012) conducted a study utilizing the convenience sampling methodology. Mrayyan found staff nurses were more likely to complete incident reports for medications in several scenarios. Specifically, nurses were likely to complete incident reports when: medications were held due to unavailable laboratory test results (61%) and antibiotic therapy was held because a patient was in a procedure (67%). Additionally, 47.1% of nurses did not report errors because he or she did not feel the error was serious enough to warrant reporting. While this study provided information related to variance in reporting medication errors, several limitations to the studies were identified. The first limitation observed in this study is that participants were selected through a convenience sampling and worked only in the Intensive Care Unit. The second limitation is the variability in how the nurse interpreted the patient scenarios.
Work Environment

Over the past decade, several studies (Ebright, Patterson, Chalko, & Render, 2003; Palese, Sartor, Costaperaria & Bresadola, 2009; Smeulers, Hoekstra, vanDijk, Overkamp & Vermeulen, 2013) have been conducted to evaluate the frequency and times of work interruptions that occur during a nurse’s shift. Ebright et al. (2003) conducted a microethnographic study using the maximum sampling technique to measure the number of interruptions a registered nurse experienced during his or her day. An interruption in this study was defined as anything that distracted the nurse from their immediate task. The researchers concluded that during a three hour period, nurses were likely to be interrupted 7-31 times with a medium interruption rate of 19. Palese et al. (2009) observed 945 medication passes in an adult medical surgical setting. These authors concluded that interruptions, during medication passes, occurred at a rate of one interruption per every 3.2 drugs given. In a more recently published study by Smeulers et al., the researchers conducted a structured observational study evaluating the number of interruptions during medication administration. These authors concluded that of the 39 observed medication passes, 1180 interruptions occurred which equated to 6.9 interruptions per hour per nurse. These studies concluded that interruptions occur in every care setting. Interruptions occur during every activity of a nurse’s day and interruptions manifest in general conversations, phone calls, noises, and work flow issues. To measure the impact that interruptions have on medication administration errors, Westbrook, Woods, Rob, Dunsmuir, and Day (2010) conducted an observational study of 4,271 drug passes. The authors concluded that as interruptions increased, so did clinical errors (Coefficient, 0.18; SE, 0.05; P < .001) (5 rights to medication
administration). The researchers further observed a 12.1% increase in procedural errors (failure to read drug labels, check patients arm band, double check high risk drugs, and poor medication preparation techniques) for every interruption.

In an observational study, researchers examined the frequency of interruptions that nurses experience during medication administration in a single medical care unit (Biron, Lavoie-Tremblay, & Loiselle, 2009). Two trained research assistants observed 102 medication administration rounds for a total of 59 hours 29 minutes of surveillance time. The researcher concluded that nurses experienced 374 interruptions or 6.3 work interruptions (WI) per hour during medication related activities. The researchers found that other nurses were the number one cause of medication related interruptions, both during medication preparation (n= 36; 29.3%) and administration (n=29; 11.9%). The second of interruptions observed by the researchers were self-initiated interruptions (drug preparation: n=21; 17.1%; drug administration: n=41; 16.9%). While this study does expose the volume of interruptions nurses experience during medication administration, the results must be viewed with caution. The study was conducted in a single patient care unit using a convenient sampling methodology. Finally, the study was conducted in Canada where healthcare regulations vary from that of the United States.

Bedside Medication Verification

Helmons, Wargel, and Daniels (2009) evaluated the effectiveness of bar scanning electronic medical record (eMAR) in conjunction with computer physician order entry (CPOE) in a prospective, before-and-after, observational study in both medical-surgical and critical area units. Utilizing the California Nursing Outcomes
Coalition (CalNOC) observation assessment tool, two pharmacists and six pharmacy students were trained to conduct the observations. One month prior to the implementation of bar scanning e-MAR, the researchers observed 1262 medication administrations (888 in medical surgical and 374 in the critical care unit). The researchers observed 1091 (697 medical surgical and 394 in the critical care unit) medication administrations during a three month period following the implementation of bar scanning eMAR. The authors found a 58% ($p<0.0001$) decrease in non-timing medication errors post eMAR implementation in the medical surgical units. In contrast, the authors found no differences in the error rates in the critical care setting when excluding non-timing errors (11% pre; 9.9% post implementation). This study had several limitations. The study was conducted utilizing the observational methodology, which has been criticized for altering behavior. The researchers in this study could be considered non-experienced as over half were pharmacy students. The final limitation to this study was that the majority of observations included one primary medication administration time, which limited the researchers’ ability to expand their findings to encompass a true medication administration error rate.

DeYoung, Vanderkooi, and Barletta (2009) aimed to evaluate the effect of BMV on medication administration error rate in an adult intensive care unit (ICU) in Michigan. Researchers observed the administration of medications during the four months before and after implementation of BMV. Research assistants observed a total of 1465 (775 pre-BMV implementation and 690 post BMV implementation) medication administrations with an average of 5 medications per medication pass. Excluded from the study were metered-dose inhalers, nebulizer treatments, fentanyl infusions, and total parenteral nutrition. All medication errors were independently reviewed by two senior
evaluators; disagreements among the two evaluators were reviewed by a third. The researchers found the medication administration error rate was 19.7% (153/775) pre BMV implementation compared to 8.7% (60/690) post implementation which equates to an overall relative risk reduction of 56% post BMV implementation (p<0.001). The most common error types both before and after BMV implementation was wrong administration time (95.4% of all errors pre-BMV and 86.7% post-BMV implementation). The authors concluded that BMV implementation was most effective in reducing wrong administration time errors. Limitations in this study should be considered. First, the study was conducted in a single hospital, which makes applicability to other organizations challenging. Second, because the study was conducted utilizing direction observation, there is a possibility of there being a Hawthorne effect. Finally, not all medication administrations were observed.

Paoletti et al. (2007) conducted a direct observation study to evaluate the impact that BMV had on MAEs in both a cardiac telemetry unit and a medical surgical unit. Four certified medication observes observed medication administrations during peak times. The results yielded a decrease of non-timing medication administration and technique errors of 54% (p=0.045). Potential adverse medication events (ADE) were further evaluated in timing medication administration errors by two independent reviewers (physician and pharmacist). Potential ADEs were evident in 213 (3.1%) errors prior to bar scanning eMAR and 114 (1.6%) error post implementation of bar scanning eMAR (50.8%, p<0.001, relative reduction rate). Timing medication errors prior to bar scanning eMAR occurred 1126 (16.7%) times compared to 891 (12.2%) times post technology implementation. The implementation of bar scanning eMAR decreased timing
medication errors by 27.3% ($p<0.001$). Potential ADEs were further evaluated in both the pre and post technology implementation which yielded little change (0.5% and 0.4%). This study can be critiqued for not expanding upon the various technologies already implemented that decrease medication errors. The study site had previously implemented computer physician order entry and pharmacy barcode verification.

Supporting the study results of Paoletti et al. (2007), Poon et al. (2010) conducted a before and after quasi-experimental study of medication transcription and administration error rates prior to and post implementation of bar scanning eMAR in a 735 bed tertiary academic medical center. The study was conducted in 35 medical surgical and intensive care units through observations conducted by trained registered research nurses two to four weeks prior to and four to eight weeks following implementation of bar scanning eMAR. The researchers observed 6,737 medication administrations prior to the implementation of bar scanning eMAR and 7,318 medication administrations following the implementation of bar scanning eMAR. The researchers categorized medication errors in one of two categories, timing (errors that occurred when medications were administered one hour before or after the scheduled time) and non-timing (all errors unrelated to timing). The researched found that prior to implementation of bar scanning eMAR technology, non-timing medication errors occurred 776 (11.5%) times compared to 495 (6.8%) after bar scanning eMAR implementation. The decrease in non-timing medication errors represents a 41.5% ($p<0.001$) relative reduction rate.
Summary

Medication administration is an error prone task with error rates of 8.4% to 27.6% (Berot, et al. 2012; Otero et al., 2008). In recent years, studies have been conducted to better understand nursing practices and the environments that contribute to medication administration errors. The 5 rights to medication administration, which were adopted by the nursing profession in the 1990s, aimed to set guidelines on medication administration safety practices. The five rights consist of confirming the right patient, dose, route, time, and drug prior to any medication administration but recent research raises the question as to whether these safety checks are common in nursing practice (Kim & Bates, 2012). Additionally, Mrayyan (2012) suggested that nurses do not know what constitutes a medication administration error thus creating the likelihood that errors go undetected.

Bedside medication verification during medication administration is a vehicle to promote patient and nurse safety. Bedside medication verification ensures the five rights to medication administration are adhered to through a network of specific patient identifiers linked to the medical record. Each medication administered is electronically verified to ensure that the medication is being administered to the correct patient at the right time, dose, route, and time. Massea Memorial Hospital (2013) found additional benefits to BMV including: more prompt and better communication among members of the healthcare team, allowed nurses to review and link pertinent diagnostic results to medications, review the physician’s order prior to administration, insert patient comments, and view the medication’s clinical indicators.
Researchers have estimated that 19% to 26% of a nurse’s time is spent administering medications (Keohan et al., 2008; Westbrook, Duffield, Li, & Creswick, 2011). Despite this high risk and time-oriented task, nurses can be interrupted up to 6.3 times in an hour thus increasing the risk of preventive errors (Biron, 2009). The implementation of bedside medication verification during medication administration has shown promising results in reducing errors from 41.5% to 58% (Helmons et al., 2009; Poon et al., 2010) yet additional studies would further justify the impact that technology has on errors.

In conclusion, medication administration is an error prone task that nurses engage in each day. Several studies (DeYoung et al., 2009; Helmons et al., 2009; Paoletti et al., 2007; Poon et al., 2010) have demonstrated a reduction in MAE after the implemention of BMV/EMR.

The next chapter will describe the data collection procedure and study methodology used to evaluate the impact that BMV/EMR had on MAE at the study site.
CHAPTER III

METHODOLOGY

This chapter describes how the comparative, descriptive design will be utilized to conduct this study. Additionally, it describes the study’s population, theoretical underpinnings, ethical considerations, specific methods for data collection, the data collection procedure, and how the data will be analyzed.

Research Methodology

The comparative, descriptive design was used to address this study’s research question because bedside medication verification “occurred naturally” within the study organization (Burns & Grove, 2009). The comparative aspect of the study design was appropriate for the research question because it allowed for the comparison of the data pre- and post- bedside medication verification implementation (Burns & Grove). This study design was also appropriate as it allowed the researcher to describe, quantify, and compare the dependent variable, medication administration errors (Burns & Grove). A descriptive study is “crafted to gain more information about characteristics within a particular field of study” (Burns & Grove, p. 237). The descriptive aspect of this study design was appropriate because data regarding medication administration errors was available from an existing database and was not subjected to manipulation or intervention (Burns & Grove).
Theoretical Underpinning

This study added to current research about barcode scanning technology used during medication administration. This study examined the consequences, anticipated versus unanticipated of the implementation of BMV, specifically medication administration errors. Concepts from Rogers’ Diffusion of Innovations framework were used to discuss how innovation (barcode scanning) affected the incidence of medication errors during the time of medication administration in nursing practice.

Population/Sample

The setting for this study was a 298 bed, not-for-profit, acute care hospital located in Northern California. The acute care hospital is a Level II Trauma Center that covers services in a seventy-five mile radius.

Three medical-surgical units, one definitive care unit, and three critical care units were included in this study. These units were chosen for this study because the implementation of bedside medication verification (BMV) occurred in each area at the same time.

The three medical-surgical units each provide care unique to patient medical conditions. For the purpose of the study, medical-surgical care was inclusive of three locations. The medical surgical areas provide care to individuals being treated for conditions such as dementia, pancreatitis, failure to thrive, acute drug or alcohol withdrawal, diabetes, stable gastro-intestinal bleeding, postsurgical care, oncology care, and chronic airway diseases. These areas have 124 licensed beds.
For the purpose of this study, the four critical care units were identified as Critical Care. The critical units provide care to individuals suffering from conditions such as trauma, surgical needs, stroke, septicemia, those who are acutely ill, require specialized monitoring, and individuals undergoing a coronary bypass or those experiencing acute coronary or vascular conditions. These areas have 58 licensed beds.

Purposive sampling was chosen for this study because “the research consciously selects certain incidents to include in the study” (Burns & Grove, 2009, p. 355). The sampling procedure targeted medication errors reported by members of the healthcare team. All reported medication errors from the study departments (medical-surgical area, definitive care unit, and critical care units) were included in this study.

Ethical Considerations

Permission for this study was obtained from the Human Subject in Research Committee (HSRC) at California State University, Chico (CSU, Chico). The study qualified for an exemption from a full HSRC board review based on exception category number three at CSU, Chico. Exemption category number three included research that involved the collection of existing data, where subject identification was impossible, that was either publicly available or was recorded by the investigator (California State University, Chico, n.d.).

Data was stored by the researcher in a password protected flash drive that was stored in a locked location where only the researcher and thesis advisors had access. The flash drive will be destroyed five years after the completion of the study. The researcher
did not maintain patient or staff member information during any part of the study or thereafter.

Protection of humans’ rights was observed in this study. The right to self-determination was observed as the researcher did not have direct contact with patients or their families thus eliminating coercion or deception (Groves & Burns, 2009). The right to privacy was ensured. Each incidence of reported errors was de-identified prior to the researcher having access and the researcher was given only information pertinent to the study. Finally, the right to autonomy and confidentiality was maintained throughout the study. The researcher had no information that could be linked to a patient or employee who made the error. The benefits of this study were identified by the researcher as contributions to information about the implementation of barcoding technology during medication administration in an acute care setting.

**Data Collection Methods**

Data were collected for this study by accessing the medication administration error incident database to determine the incidence of medication administration errors (MAE). Additionally, the study site’s financial database was accessed to calculate MAE incidence per 1000 adjusted patient-day. Both databases were used to explore the research question by addressing the aggregate and incidence of medication administration errors three months, pre-BMV implementation and a period three months post implementation.

The criteria for the selection of medication administration errors from the Incident Reporting database were derived from the study site’s definition of a medication
error. The definition of medication error at the study’s institution is any deviation from the physician’s order.

Data Collection Procedure

The researcher utilized the medical center’s medication administration Incident Reporting database specifically used for the reporting of errors (MAE). Data were formatted in an Excel worksheet. The Excel worksheet maintained compliance with the Health Insurance Portability and Accountability Act (HIPAA) of 1996 (Centers of Medicare and Medicaid Services [CMS], 1996). The Excel worksheet did not identify patient’s name or staff members involved in the error. The worksheet provided the researcher with the date of the incident, location of the incident, and the classification of MAE. The timeframe studied was July 2011 through September 2011 which represented the three month period prior to BMV implementation and January, 2012 through March, 2012 representing the three month period post BMV implementation. October, November, and December, 2011 were excluded from this study because implementation was occurring.

MAE entered in the Incidence Reporting system was originated by employees of the medical center upon identifying that an error had occurred. The Incidence Reporting system required the writer to enter a detailed narrative describing the incident. Each MAE was reviewed by a single Pharmacist in the Quality Management Department who determined the category of each medication error. At the time of the report, queries were made to department managers, staff nurses, and physicians to determine how the error occurred and to ensure proper categorization of the MAE was made.
Patient-days data were obtained through the Finance Department at the study site. The researcher obtained patient-day data for the three month period prior to BMV implementation. The researcher requested only the patient-day data for the study areas aggregately and the patient-day data by medical-surgical and critical care departments. The researcher further obtained patient-day data for the three months post BMV implementation. The researcher requested only the patient-day data for the study departments as a whole and the patient-day data by medical-surgical and critical care departments.

Data Analysis

The purpose of study was to address the consequences of BMV; in particular, medication administration errors. Since the primary purpose of BMV is to prevent medication errors, medication administration errors incidence was the variable for this study.

Medication administration errors were obtained from a pre-existing Incident Reporting database maintained by the study site to answer the research question. Aggregate results were displayed using a frequency table based on how each error was categorized. Errors were categorized first as a whole aggregate number of all medication administration errors. Errors were then broken into the error type specific to the 5 rights of medication administration which included right patient, dose, time, strength, and route.

The study further examined the incidence of reported medication administration errors by locations. Aggregate results were displayed using a frequency table based on location of the error. Aggregate numbers were utilized to indicate the
location where the medication administration error occurred. The locations that were included in this study were Medical Surgical and Critical Care.

The incidence of medication administration errors was obtained through a standardized comparison of patient-days data. Mosby (2009) defined patient days as the sum of all days each patient stayed in a designated unit. Patient days have been utilized in previous studies surrounding medication error research (Classen et al., 1997; Bates, Leape, & Petrycki, 1993; Bates et al., 1995; & Lustig, 2000). The incidence of MAE was determined using the following equation N/Patient-Days times 1000. Patient-days data was an appropriate denominator for this study in determining the incidence of MAE as it allowed the researcher to compare the error rate based upon changing patient volumes and allowed comparison of the error rates among various settings (The American Society for Clinical Laboratory Science, 2013).

Reliability/Validity

Threats to internal reliability were a disadvantage of using data from an existing data source. These threats included the manner in which the data were obtained, via a self-report system as opposed to direct observation. Direct observation is considered more accurate in detecting medication administration errors (Flynn et al., 2002). Several studies have demonstrated that medication errors are underreported thus threatening the reliability in this study (Dunn, 2003, Gladstone, 1995, Osborne, Blais, & Hayes, 1999 Mrayyan, Shishani, & Al-Faouri, 2007). The study organization has provided ongoing education to staff, both prior to and after this study time period specific to policy and procedures for reporting medication administration errors. Each employee has a
responsibility to report all detected and potential errors through the Incident Reporting System to allow for the review and cause determination of all errors.

Another threat to internal reliability was assessment bias (Dworkin, 1987; Hess, 2004; Pan, Fergusson, Schweitzer, & Herbert, 2005; VanKoss Krowchuk, Moore, & Richardson, 1995). Bias is defined as a deviation away from the truth often caused by a failure in obtaining information from all stakeholders (Burns & Grove, 2009). Assessment bias could occur in two instances specific to medication administration errors. The first bias was the reporter’s belief that there was an error. This bias was addressed at the study site through ongoing education related to the policy and procedure related to the reporting of all potential and actual medication errors. The second bias could occur at the time the error was classified. This bias was also addressed by the study site through internal review methods. The staff member reporting the error was asked to provide a narrative of the event surrounding the medication administration error. Each error was reviewed by a member of the Quality Management Department who sought clarification into the error from members of the nursing staff, medical staff, and pharmacy staff prior to categorizing the error. Each error and categorization was later reviewed by various members of the study site.

Threats to data reliability were potential disadvantages in this study. The study site had conducted ongoing staff education both prior to and after the initiation of this study to reduce the risk of underreporting of errors as well as reducing bias through interdisciplinary review of the categorization of medication administration errors. Despite the potential threats to data reliability, and data collection, self-report was appropriate for
this study as it is the method utilized by the study site to collect medication administration error data.

Summary

A comparative, descriptive study design was used in this study to describe the incidence of medication administration errors, three months prior to and after the implementation of bedside medication verification. The data collected from this research study was evaluated to display the frequency of medication administration errors by type and location during the study period. These data were obtained through the study site’s Self Reporting Incident database. Patient days were used to address the incidence of medication administration errors per 1000 patient day. Patient day data was obtained through the Finance Department for the locations included in this study.

The next chapter will present the results from the data collection.
CHAPTER IV

RESULTS

Introduction

Data, specific to the five types of medication administration errors (MAE) (wrong patient, dose, route, time, and medication), were obtained during two primary periods of time. The data on medication administration errors in addition to patient-days data were used to determine the incidence of MAE in nursing practice. This chapter discusses the results for the study question- What is the impact of the implementation of bedside medication verification technology on the incidence of medications errors during a three month period pre- and post-implementation of this technology at an acute care facility in northern California?

Discussion

This research study examined the impact of bedside medication administration (BMV) in nursing practice. Specifically, this study examined whether BMV decreased the incidence of MAE at the point of medication administration. The study first examined the aggregate number of reported MAE three months prior to the implementation of BMV followed by a three month period following the implementation of BMV. Secondly, this study examined MAE by two levels of care, Medical Surgical
and Critical Care. Finally, the study examined the aggregate number of MAE in relation to patient-day data during the study periods to determine the incidence of each error type.

Results

Medication administration errors are self-reported and maintained in a centralized reporting system at the study site. A report summary was obtained in an Excel format from the department that oversees all MAE. The report summary included the date frame, location, contributions, and the narrative of each MAE during the study period. At the time of and immediately following the reporting of each MAE, information specific to the situation were investigated. The investigation of each MAE could have included but not limited to, staff interviews, chart reviews, and system reviews. At the conclusion of each investigation, the type of error was determined and validated via the oversight of the Medication Error Reduction Committee. Each error was classified and recorded.

The research question was addressed by describing MAE incidence during the three month period (Pre-) prior to the implementation of BMV and from a three month period (Post-) following the implementation of BMV. Prior to the implementation of BMV, 122 MAE were reported; post BMV implementation, 68 were reported. Prior to the implementation of BMV, wrong time (80.3%) was the most commonly MAE type reported followed by wrong dose (11.5%). Wrong patient events occurred four times (3.3%), wrong drug events occurred five times (4.1%) while wrong route events once (0.8%) pre-BMV implementation. Post BMV implementation, wrong time errors (61.8%) remained the highest reported MAE followed by wrong dose errors (32.3%). Wrong drug events occurred four times (5.9%) while both wrong patient and wrong route MAE were
eliminated following the implementation of BMV. In evaluating wrong dose events both pre and post BMV implementation, 20 errors were attributed to human error (incorrect pump programming). Pre-implementation, five of the 14 reported dose errors (35.7%) were related to pump programming errors while 15 of the 22 (68.2%) reported dose errors post BMV implementation were pump programming errors. The data were examined using a frequency distribution table. As displayed in Table 1 (Number and Frequency of Medication Administration Errors during Pre- and Post-), there were a total of 190 errors reported prior to and post BMV implementation. Figure 2 (Number Medication Administration Errors during Pre- and Post-) displays the total reported MAE in a graph format.

**TABLE 1**

*Number and Frequency of Medication Administration Errors during Pre- and Post-*

<table>
<thead>
<tr>
<th>Type of Medication Administration Error</th>
<th>Pre-</th>
<th></th>
<th>Post-</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Frequency %</td>
<td>N</td>
<td>Frequency %</td>
</tr>
<tr>
<td>Wrong Patient</td>
<td>4</td>
<td>3.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wrong Dose</td>
<td>14</td>
<td>11.5</td>
<td>22</td>
<td>32.3</td>
</tr>
<tr>
<td>Wrong Route</td>
<td>1</td>
<td>0.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wrong Drug</td>
<td>5</td>
<td>4.1</td>
<td>4</td>
<td>5.9</td>
</tr>
<tr>
<td>Wrong Time</td>
<td>98</td>
<td>80.3</td>
<td>42</td>
<td>61.8</td>
</tr>
<tr>
<td>Total</td>
<td>122</td>
<td></td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>
This research study further assessed the incidence of MAE based on location. Aggregate results displayed in Table 2 shows the number and frequency of MAE in both the Medical Surgical Care areas and Critical Care areas pre- and post-implementation of BMV. Prior to the implementation BMV, 86 of the 122 (70.5%) MAE occurred in the medical surgical care units while 36 (29.5%) occurred in the critical care area. After the implementation of BMV, 35 of the 68 (51.5%) errors occurred in the medical surgical care areas while 33 (48.5%) occurred in the critical care area indicating that errors occur in both care settings. Wrong timing errors were the most frequently reported MAE in both the medical surgical and critical care areas pre- and post BMV implementation followed by wrong dosing errors. Displayed in Table 2 are the total number of reported MAE by location both pre- and post- BMV implementation. Figure 3 (Frequency of Medication Administration errors Pre- and Post- implementation of BMV by location) will display the result using a bar graph.
TABLE 2

Number and frequency of Medication Administration Errors during Pre- and Post-Implementation of BMV Based on Location

<table>
<thead>
<tr>
<th>Type of Medication Administration Error</th>
<th>Pre-</th>
<th>Post-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Frequency %</td>
</tr>
<tr>
<td>MEDICAL SURGICAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrong Patient</td>
<td>4</td>
<td>4.6</td>
</tr>
<tr>
<td>Wrong Dose</td>
<td>8</td>
<td>9.3</td>
</tr>
<tr>
<td>Wrong Route</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Wrong Drug</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Wrong Time</td>
<td>72</td>
<td>83.7</td>
</tr>
<tr>
<td>Total</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>CRITICAL CARE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrong Patient</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wrong Dose</td>
<td>6</td>
<td>16.7</td>
</tr>
<tr>
<td>Wrong Route</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wrong Drug</td>
<td>4</td>
<td>11.1</td>
</tr>
<tr>
<td>Wrong Time</td>
<td>26</td>
<td>72.2</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100</td>
</tr>
</tbody>
</table>

Patient-day data were obtained from the Finance Department at the study site for the study periods. Patient day information was collected for the period of time of July through September 2011 and January through March, 2012. During the period of time,
July through September 2012, total patient days for both the Medical Surgical Care and Critical Care divisions were 13,246. The researcher received patient day data for the period of time of January through March, 2012. The patient-day total was 14,088. The incidence of medication administration errors was calculated using the formula, \( n \) divided by patient days times 1000. Prior to BMV, a MAE was likely to occur 9.2 times in 1000 patient days as opposed to 4.8 times post BMV. Wrong time errors remain the most common incidence of MAE both pre- (7.4) and post- (3) implementation than another reported MAE. Figures 4 and 5 display the incidence of each MAE during the study period using Patient-day data. Figure 4 displays the incidence of MAE in a bar graph format.
Figure 4. Incidence of medication administration errors during pre- and post-implementation of BMV based on Patient-days.

Figure 5. Incidence of medication administration errors during pre- and post-implementation of BMV based on Patient-days.
Summary

This chapter presented the results of this study. Table 3 displays the results of reported medication administration errors during a three-month period before and after the implementation of bedside medication verification.

TABLE 3

<table>
<thead>
<tr>
<th>Incidence of Medication Administration Errors during Pre- and Post- Implementation of BMV Based on Patient Day Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Medication Administration Error</td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Wrong Patient</td>
</tr>
<tr>
<td>Wrong Dose</td>
</tr>
<tr>
<td>Wrong Route</td>
</tr>
<tr>
<td>Wrong Drug</td>
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<tr>
<td>Wrong Time</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

During period one (pre- BMV implementation), 122 errors were reported compared to 68 errors during period two (post-BMV implementation). Timing errors (pre-BMV implementation 80.3%; post-BMV implementation 61.8%) remained the most frequent MAE reported during both time periods. This study reported an increase in wrong dosing errors pre- BMV implementation (14; 11.5%) compared to (22; 32.3%) post- implementation. Wrong drug events increased in total number from 5 (4.1%) pre-
BMV implementation compared to 4 (5.9\%) post-implementation. Both wrong patient and route events were eliminated post BMV implementation.

The next chapter will explain the meaning of the results from this study.
CHAPTER V

DISCUSSION, CONCLUSION
AND RECOMMENDATION

This chapter provides a discussion of the findings related to the impact that bedside medication verification (BMV) had during medication administration in nursing practice. It also discusses the limitations of the study, implications for practice, research, and education. This chapter concludes with a summary and recommendations.

Discussion

This research study set out to determine whether the implementation of bedside medication verification had an impact on the incidence of reported medication administration errors (MAE) at a community hospital in Northern California. This study was designed to evaluate reported medication administration errors three months prior to (July through September 2011) and a three month period (January through March, 2012) following the implementation of the technology BMV.

Roger’s Diffusion of Innovation guided the discussion for this study. Specifically, what effects or consequences the implementation of BMV/EMR had on medication administration errors at the study site.

Timing errors remained the most frequent MAE reported during both time periods in this study. Several studies have reported timing errors being the most frequent
MAE (Barker et al., 2002; Berdot et al., 2012; and DeYoung, Vanderkooi, and Barletta, 2009). In a recent study conducted by Teunissen et al. (2013) the authors concluded that timing errors can impact the clinical outcome of a patient. While the authors acknowledged a low risk for patient harm, (0.07%), timing errors can resulted in the potential for food-drug interactions or drug-drug interactions. Despite the implementation of BMV, technology has little impact in decreasing these error types. The timing of medication administration remains the responsibility of the nurse; the technology will alert the nurse that the medication is being administered outside of the designated time frame.

The second most frequently reported MAE during both time periods was wrong dose errors. Previous studies have concluded that wrong dosing errors occurred 0% to 30% (Barker et al. 2002; DeYoung et al., 2009; & Otero et al., 2008) without the implementation of BMV compared to 3.3% to 9% post BMV implementation (DeYoung et al; & Helmons et al, 2009). This study noted that pump programming errors were the largest contributor to dosing errors. Trbovich, Pinkney, Cafazzo, and Easty (2010) studied the occurrence of programming errors in relation to smart intravenous pump technology. The authors found that when an infusion was ordered continuously, there was a 94% ($p>0.1$) accuracy rate compared to a 90% ($p > 0.01$) accuracy rate in intermittent pump programming. The authors further found that secondary infusions were correctly set on the pump 67% ($p>0.01$) of the time. Trbovich et al. demonstrated that wrong dosing errors occur by virtue of human error. At the study site, the BMV technology is not connected to the intravenous pump technology. Again, the medication would have
registered as correct but the technical aspect of correctly programming the machine is dependent on the nurse.

The third most frequently reported MAE type was wrong drug events. Several studies have documented wrong or unauthorized drug events occurring 0.3% to 4% (Barker et al., 2002; Berdot et al., 2010; DeYoung et al., 2009; & Westbrook et al., 2010) without the implementation of a BMV system. The wrong drug events at the study site were unrelated to medications being verified via the bar scanning technology but rather physician parameters not being followed. In these instances, the nurse would have been required to review the comments associated with each medication to know the drug parameters and when to make changes to the drug therapy. Additional consideration must be given to the lack of standardization of drug error classifications. This study looked at errors based on one of the five rights in drug administration (wrong patient, drug, route, time, or dose) and did not further categorize errors as omission or unauthorized method as seen in other studies (Barker et al.; Berdot et al.; DeYoung et al. & Westbrook et al).

Wrong patient and route events were eliminated at the study site post implementation of BMV. The purpose of BMV is to add an additional layer of safety in medication administration in nursing practice. Bar code scanners are used to electronically verify that the patient and medication scanned are what the physician prescribed. When a miss-match in either the medication or patient is identified the BMV system will alert the nurse that a discrepancy has occurred and that the medication should not be administered to that patient. This warning system may explain how wrong patient events were eliminated at the study site.
Variations in findings of the comparison studies illustrate the challenges of providing comparison data and discussion. Four of the seven studies used for comparison were conducted using the direct observation methodology (Barker et al., 2002; DeYoung et al., 2009; Helmons et al., 2009; Westbrook et al., 2010) whereas Berdot et al. (2010) used the disguised observation methodology and Otero et al. (2008) utilized a cross-sectional study. Additionally, one of the seven studies had been conducted in the ICU setting (DeYoung et al.); one in both the medical surgical and critical care setting (Helmons et al.); one in a pediatric hospital (Otero et al.); and three in acute care settings (Berdot et al.; Barker et al.; Westbrook et al.). The variation of study methodologies makes comparisons of MAE challenging. The primary reason is that some collection methods observe each medication administration and compare the drug administered to the physician’s order while reviewing the study sites policies and procedures. Other studies, such as the method used in this study, rely solely on self-report of medication administration errors. Additionally, areas, such a critical care and emergency departments, administer medications with complex dosing regimens which are associated with increased risks of errors (Duthie et al., 2005).

While the implementation of BMV does show an improvement in medication administration safety, the technology does present new challenges. Miller, Fortier, and Garrison (2011) observed three clinician workarounds per medication administration pass. These workarounds included bypassing alerts, not scanning the medication or the patient, or scanning the medication after it had been removed from the packaging. The inherent consequences of technology are the workarounds nurses explore that decrease
the amount of time spent administering medications but that diminishes the ability of the technology to function as a safety feature.

Limitations of the Study

This study was limited to one study site for pre- and post- BMV comparison of reported MAE. The study was limited to only those areas that implemented BMV (Medical Surgical and Critical Care Units), which limits comparison to other clinical areas.

The methodology of collecting and reporting MAE is another limitation of this study. MAE was collected via self-report and data were reviewed retrospectively. Direct observation is considered more accurate in detecting medication administration errors (Flynn et al., 2002) and capturing errors that go unreported (Dunn, 2003; Gladstone, 1995; Osborne, Blais, & Hayes, 1999; Mrayyan, Shishani, & Al-Faouri, 2007). However, in a statement issued by the Institute of Safe Medication Practices (2014), benchmarking medication error rates is not possible as each hospital and organization is different and measure errors in a different manner. While this study provides results of medication administration error rates both pre- and post- BMV implementation, the results may not be applicable to other healthcare settings. Bias may also be considered a limitation in this study. As previously discussed, direct observation is considered more accurate in detecting medication errors (Flynee et al., 2002) and errors may go unreported in a self-report error system. The primary reason for errors going unreported is that the error must first be detected, which may go unnoticed by the individual administering the medication. Secondly, medication errors may go unreported
for fear of reprimand or self-esteem bias. Wolf and Hughes (2008) cite that clinicians often fear that reporting of errors will result in career threatening disciplinary actions, fear of litigation, and moral residual.

Implications for Practice

Nurses will continue in the practice of medication administration in the acute care setting. The implications that BMV has to decrease the incidence of MAE in nursing practice should be further explored. While BMV has been shown to decrease MAE, nurses must still be trained and show competence in the process of preparing, administering, and monitoring the effects of a medication as technology alone does not ensure safe administration practices. More robust training programs are required on medication delivery systems to ensure the nurse can properly program the medication administration pump to deliver the correct medication dose.

Organizations where medications are administered should consider fostering a “just culture” to promote medication administration error reporting. According to the Agency for Healthcare Research and Quality (2012), a just culture focuses on the identification of system issues that lead to unsafe clinical practices. A just culture does not ignore inappropriate behavior but rather differentiates behaviors that are reckless, at-risk, or human. By promoting a culture of safety, healthcare providers are more likely to report not only actual errors but potential errors that place organizations in a vulnerable state for a catastrophic error (Wolfe & Hughes, 2008).
Implications for Research

More research is needed in the form of robust observational design to further explore the impact of bedside medication verification in nursing practice. This study evaluated only the errors related to the MAE using the self-report methodology; further research is warranted in evaluating the errors during each stage of the medication process (ordering, processing, and administration).

This study did not examine the scanning practices associated with the reported MAEs in part because this information was not collected as part of the MAE review process at that time. In recently published data, scan rate compliance ranges from 80% to 97% (Early et al., 2011; Poon et al., 2010). Research is warranted to determine whether scanning compliance has an impact on MAE.

This study did not examine the root cause of each medication administration error. Research is warranted in the evaluation of wrong dose and wrong drug events associated with BMV systems as these events increased in percentage following the implementation of technology. More specifically, additional research is needed on the use of smart pumps in the clinical setting. A better understanding on nurse practices can help in the integration of smart pump technology with BMV systems. Understanding how and why these errors occur will assist in error reduction strategies.

Implications for Education

Medication administration is a core task carried out by nurses in an acute care setting and will account for 19% to 26% of his or her work day (Keohan et al., 2008; Westbrook, Duffield, Li, & Creswick, 2011). Hughes and Blegen (2008) identify several
areas of medication risk specific to medication administration that should be considered as part medication administration training. These potential risks include medications that have similar names and packaging, medications that require laboratory monitoring to ensure safe dosing, and medications not commonly used. Educators have an opportunity to teach students the fundamental skills associated with safe medication administration while incorporating identified high risk areas into the lesson plan. This education should be going, comprehensive and occur with or without the utilization of technology.

The practicing nurse must understand that the technology is a tool to promote patient safety but does not prevent all error types. Education should prepare nurses for the real life experiences via a virtual environment. Nurses must understand that warnings will display in an attempt to prevent errors. One study found that overused warnings and alerts, designed to prevent errors, were overridden 49 to 96% of the time (Van Der Sijs, Aarts, Vulto & Berg, 2006). Educators play a vital role in teaching nurses the limits of the systems while allowing them to explore various scenarios. It is vital that educators ensure competency on BMV systems and medication delivery systems to decrease errors associated with incorrect equipment use or human error.

**Conclusion and Recommendation**

This study set out to examine the impact of the implementation of bedside medication verification technology on the incidence of medications errors during a three month period pre- and post-implementation of this technology at an acute care facility in northern California.
The results from this study demonstrated that the implementation of BMV decreased the incidence of a MAE from 9.2 to 4.8 per patient day. Despite the decrease in overall MAE post BMV implementation, this study observed an increase in wrong dose and wrong drug errors by percentage. The increase of wrong dose and wrong drug errors warrants further investigation to determine the case of such errors and determine error eliminating strategies.

This study could be replicated at other sites though the study and data collection methodology should be considered. Careful thought should go into the study design and the goal of the study must be clearly defined prior to data collection. Thoughtful planning will allow the researchers to appropriately compare the findings of the study to previously published research.

While BMV does not eliminate all medication administration, the post-BMV implementation results from this study validate that BMV was helpful in reducing the overall number reported MAE and eliminating wrong patient and route events in the study site’s acute care setting.
REFERENCES


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INSTITUTIONAL REVIEW BOARD
CLEARANCE

June 18, 2013

Amber Genato
47 Abbott Circle
Chico, CA 95973

Dear Amber Genato,

As the Chair of the Campus Institutional Review Board, I have determined that your research proposal entitled "THE IMPACT OF INTRODUCING BEDSIDE MEDICATION VERIFICATION ON THE INCIDENCE OF MEDICATION ADMINISTRATION ERRORS" is exempt from full committee review. This clearance allows you to proceed with your study.

I do ask that you notify our office should there be any further modifications to, or complications arising from or within, the study. In addition, should this project continue longer than the authorized date, you will need to apply for an extension from our office. When your data collection is complete, you will need to turn in the attached Post Data Collection Report for final approval. Students should be aware that failure to comply with any HSRC requirements will delay graduation. If you should have any questions regarding this clearance, please do not hesitate to contact me.

Sincerely,

John Mahoney, Ph.D.
Chair
Human Subjects in Research Committee

Attachment: Post Data Collection Report

cc: Peggy Rowberg (200)
HUMAN SUBJECTS IN REVIEW COMMITTEE
Post Data Collection Questionnaire

Under Federal law relating to the protection of Human Subjects, this report is to be completed by each Principal Investigator at the end of data collection.

Please return to: Marsha Osborne, HSRC Assistant
Office of Graduate Studies
Student Services Center (SSC), Room 460
CSU, Chico
Chico, CA 95929-0875

Or Fax to: Marsha Osborne, 530-898-3342

Name: Amber P. Genato Chico State Portal ID:004959709

Phone(s) (530) 512-2784 Email: rm03ca@aol.com

Faculty Advisor name (if student): Margaret Rowberg Phone (530) 898-3493

College/Department: School of Nursing

Title of Project: The Impact of Introducing Bedside Medication Verification on the Incidence of Medication Administration Errors

Date application was approved (mo/yr.): 06/2013 Date collection complete (mo/yr.): 12/2013

How many subjects were recruited? n/a How many subjects actually completed the project? n/a

*HARM—Did subjects have severe reactions or extreme emotional response? n/a

If yes, please attach a detailed explanation:

Your signature: Amber P. Genato Date: 6/18/2014

*Final clearance will not be granted without a complete answer to this question.

Approved By: John Mahoney, Chair Date: 6/25/14

*************** IMPORTANT: If you will or have used this research in your project or thesis you are required to provide a copy of this form (with John Mahoney’s signature in place) to your graduate committee.

Do you want a photo copy of this form emailed to you? yes

If yes, provide email address: rm03ca@aol.com

7/9/14

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