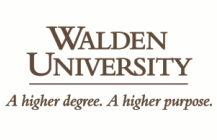

2018

Usefulness of Medication Scanners in Clinical Practice: A Systematic Review

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This is to certify that the doctoral study by

Laura Cure

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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Walden University
2018

Abstract

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Laura L. Cure

MS, Walden University, 2015

BS, Edison State College, 2013

Project Submitted in Partial Fulfillment

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Doctor of Nursing Practice

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November, 2018

Abstract

Thousands of people die each year due to preventable medication errors. Barcode medication administration (BCMA) systems can reduce medication errors at the point of care, thus increasing patient safety. The purpose of the project was to gather evidence regarding BCMA usefulness in reducing medication errors. Kurt Lewin's 3-step change theory was used to guide this project. The nature of this project was a systematic reviewof the literature pertaining to the effectiveness of using BCMA systems to reduce medication errors in at the point of care in the hospital setting. The Johns Hopkins nursing evidence-based practice model and tool kit was used to evaluate each article. The review comprised one systematic review, one integrative review, and 6 before-and-after observational studies. The results of each study indicated that the use of a BCMA system could reduce medication errors but not completely eliminate them. The findings of this project contribute evidence that BCMA systems can assist the clinician in safely administering medication. Dissemination of the evidence will contribute to a positive change by promoting greater understanding of the effectiveness of using BCMA systems in all areas that administer medication.

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Dedication

I dedicate this paper to my mother Lillian, husband Donald, and mythree wonderful children Kyle, Brandon, and Cheyenne. My strength throughout this journey has come from their love and unending support and understanding. You all have been my inspiration to pursue further education. I love you all dearly.

Acknowledgments

I wish to communicate my appreciation and gratitude to all of my program professors. Each of you shared knowledge and your expertise that were the building blocks to my success. Thank you to Dr. Joanne Minnick and Dr. Amelia Nichols for all your guidance throughout the project process. You have shared your knowledge and expertise and given me a firsthand look at what it means to be a Doctor of Nursing knowledge and showing me what it means to be a true leader and scholar.

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Section 1: Nature of the Project

Introduction

Healthcare service areas strive to provide patients with safe high-quality care and services, yet medication errors still occur at an alarming rate. This is not just a national but also a global issue that all healthcare arenas are struggling with. Medication administration is carried out in hospitals everywhere. Every time a medication is administered, the risk of harm increases (World Health Organization [WHO], 2016). The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has acknowledged this problem and made improving medication safety a national patientsafety goal. Bar code medication administration (BCMA) systems can help decreasethese errors from occurring, thus increasing patient safety (Patient Safety Network, 2017). In 2012, the Centers for Medicare and Medicaid Services (CMS) proposed stage 2 criteria of meaningful use. Stage 2 addressed patient harm due to medication errors. American Hospitals had until 2014 to have 10% of all medication orders electronically tracked in the electronic medical record (EMR). BCMA systems were one way to achieve stage 2 criteria (Kelly, 2012).

BCMA scanners are used to increase medication administration safety. The use of medication scanners for medication administration safety is second only to smart pumpuse. (Seibert, Maddox, Flynn, Williams, 2014). The barcode medication scanner is ahandheld apparatus used to scan both the patient's wristband and medication to beadministered. The scanner is used in conjunction with the eMAR and computer physician order entry (CPOE) system to ascertain that six of the seven rights are observed. The

seven rights are: the right medication, the right route, the right dose, the right patient, the right time, the right documentation, and the patients' right to refuse. The first six rights are met when the patients' armband and medication are scanned. The seventh right is the patients' right to refuse medication after receiving information regarding the benefits and importance of the medication being administered. Refusal of the medication is documented in the medication administration record (MAR) after scanning has been completed (Northern Territory of Australia, 2015).

A systematic review of the literature regarding medication scanner use in the perioperative area of hospitals was conducted. The perioperative area was chosen for this project due to its underutilization of available BCMA technology to reduce medication errors. All patient care areas throughout the institution, with the exception of the emergency room (ER) and surgical services, have used BCMA scanning systems for approximately 10 years. Currently leadership is not convinced that instituting BCMA in this area would be more beneficial than continuing with the process already in place. The current process is to check the eMAR for the medication, identify the correct drug, dose, and route, check patient armbands, and administer the drug. The pharmacy does not review the order before administration in the perioperative area, which could increase the risk of a medication error occurring. The perioperative area could benefit from the use of a BCMA scanning system to increase patient safety by reducing potential and actual medication errors. For this reason, a systematic review of the evidence was done and the findings will be disseminated to senior leadership, managers, and directors of the perioperative area.

Problem Statement

The problem that was identified is the underuse of available BCMA technology to provide safe medication administration to perioperative patients. The focus of this project was to elicit buy in from stakeholders regarding the need to institute barcode medication scanners in the perioperative area for patient safety. Decreasing medication errors for patient safety was at the forefront of this project.

The need to address the problem lied in medication errors that could potentially harm patients. Over seven million patients are affected each year by medication errors that are preventable (Da Silva & Krishnamurthy, 2016). These errors come at a cost of approximately $20 billion dollars (Da Silva & Krishnamurthy, 2016). The cost of medication errors is not only monetary; every year, approximately 7,000 people die due to these errors (Agency for Healthcare Research and Quality, [AHRQ] 2017.). A vital step in improving patient safety is to increase medication administration safety. Barcode scanning systems can do this. Having a better understanding of the evidence behind using barcode scanners in conjunction with the eMAR and CPOE may assist institutional leaders in making decisions regarding their use in the perioperative area.

This project holds significance to nursing practice because it increases patient safety. Using a BCMA scanning system assists nurses in assuring that six of the seven rights are met before administration of medication. Using this technology can help nurses avoid errors affecting the patient.

Purpose

Identifying the available evidence regarding the use of BCMA systems to reduce medication errors was the purpose for this systematic review project. A systematic review was completed and the evidence shared with stakeholders in hope they would change their decisions regarding using barcode scanners in the perioperative department. At thistime, the belief of leadership is that it would encompass too many departments to initiate such a change and would be difficult to implement due to the fast-paced nature of the department.

The gap in practice this project addressed is that perioperative services are one of the only areas in the institution that does not use this technology for patient safety. This project has the potential to close the practice gap by convincing stakeholders and end users of patient safety issues related to medication errors. If leadership decides to institute the use of barcode scanners and medication errors are decreased, patient safety will be increased.

The practice focused question that drove this systematic review was: In perioperative services, does using BCMA to administer medications decrease medication errors compared to not using BCMA, and thereby increase patient safety?

Nature of the Doctoral Project

The nature of this doctoral project was a systematic review of the current literature as it pertained to barcode scanner use and reduction of medication errors. As a Doctorate of Nursing Practice (DNP) study, use of evidence-based practice was imperative to bring about change to decrease medication errors and increase patient

safety. This systematic review and dissemination of the findings will give leadership the necessary information to make a best practice decision regarding BCMA use in the perioperative area. If the evidence shared causes stakeholders to institute BCMA use inthe perioperative area, medication errors could be decreased and patient safety increased.

This systematic review was conducted using the following databases: Cumulative Index for Nursing and Allied Health Literature (CINAHL) plus with full text, Medline with full text, ProQuest, and Google Scholar. The Johns Hopkins nursing evidence-based practice (JHNEBP) model tool kit was used to categorize findings. The methodology and search terms used will be discussed in Section 3.

The purpose of this systematic review was to close the gap in nursing practice that was identified. The gap in practice that was identified is the underuse of BCMA technology in the perioperative area. Currently, the BCMA system is used in all areas except the emergency department (ED) and perioperative services. This project's purpose was to show stakeholders and end users the evidence showing that medication errors can be decreased, thus increasing patient safety with the use of a BCMA scanning system. The findings of this systematic review show that using BCMA does decrease medication errors, thus increasing patient safety.

Significance

The stakeholders involved in this project were institutional leaders, nurses, pharmacists, and patients. Barcode scanning systems have been used for many years in hospitals across the United States. Proper administration of medication meeting the seven rights is imperative for patient safety. By using BCMA technology, six of the seven rights

will be verified, thus reducing medication errors (Wakefield, Ward, Loes, & O'Brien, 2010). The significance of this systematic review project is that it helped institutional leaders understand the evidence available, showing barcode scanner use is a best practice for patient safety. Increased patient safety through decreased medication errors can save the institution money, provide better outcomes for patients, and increase nursesatisfaction.

Summary

In Section 1, background information was presented regarding the purpose of this systematic review project, the nature of the project, and the practice-focused question for the project. Background information was given about the severity of medication errors and how BCMA scanner system use can help reduce medication administration errors, thus increasing patient safety. Section 2 will present the theory and model that were used for this project. The project's relevance to nursing practice will also be presented along with a description of the role of the DNP student.

Section 2: Background and Context

A medication error is an event that occurs which could have been prevented where patient harm or inappropriate use of medication occurred. Medication errors can be prevented through the use of BCMA technology. BCMA technology assists the nurse in verifying that the seven rights have been met (Shah, Lo, Babich, Tsao, & Bansback, 2016). BCMA systems have been implemented in many hospitals across the United States. The types of errors that BCMA was specifically developed to decrease are wrong route, wrong form, wrong drug, wrong dose, and omission of drug. This technology used in conjunction with the eMAR and CPOE can help reduce medication administration errors by creating a safety barrier for the nurse (California Hospital Patient Safety Organization, 2014). A systematic review of the literature was conducted regarding medication scanner use in the perioperative area. The problem this project addressed is that barcode scanners are not used in the perioperative area in the chosen institution.

The purpose of this project was to educate and elicit agreement from the institution's stakeholders about the need for barcode scanner use in the perioperative area. Upon completing this systematic review of the literature, the evidence was shared with stakeholders so they would reconsider use of barcode scanners in the perioperative area. Before dissemination of the evidence, the consensus of institutional leaders was that too many departments would be affected if barcode scanner use were initiated in this area. The reasoning behind this consensus was that it would encompass too many departments to initiate such a change and would be difficult to implement due to the fast-paced nature of the department.

Theoretical Framework

The theory and model that were used to inform this project were Kurt Lewin's three-stage change theory and change model. Lewin created this model because he believed that in regard to change, there is a balance of forces working in opposite directions. He believed driving forces facilitate change and restraining forces hinder change. In an institution, driving forces push staff in the needed direction to facilitate change, and restraining forces therefore push staff in the opposite direction, hindering change. His theory of change has three distinct stages, these stages are unfreezing, changing and refreezing. (Kaminski, 2011).

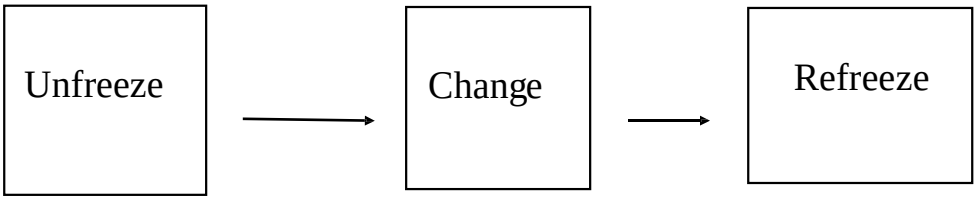

Figure 1. Lewin's change model.

First, the existing way of thinking must be changed. This is known as the unfreezing stage. In this stage, the status quo way of thinking is changed through reeducation, brainstorming sessions, and dissemination of evidence to show why the change needs to be made. After the current behavior has been unfrozen, stage two can begin. This stage is known as the move to a new situation. Here, the stakeholders are made to understand and subsequently accept that the new way will work better than the old way. The third stage is known as the refreezing stage. In this final stage, the new

behaviors are put in place. Education, policies, and a support system remain in place to assure continued success of the initiated practice change (Kaminski, 2011). Lewin's three-step change theory and model were appropriate to guide this project to its completion.

Some prevailing beliefs prior to this study were that not using barcode scanners in perioperative services has worked fine, so there was no need for change. The intent of this project was that through a systematic review of the literature using Lewin's theory with translation and dissemination of the evidence, current thinking could be changed. After step one is completed, new thinking can be introduced and subsequent refreezing can be accomplished.

Change management is defined as the process of constantly renewing the organization's direction, abilities, and structure. The changes that are made are to serve the needs of internal and external customers. It is immaterial how big or how small a change is, as long as it serves the customers of the institution (Hussain et al., 2016).

Definition of Terms

Barcode medication administration (BCMA): A system which requires coded medications and a barcode scanner in conjunction with an EMR that helps the nurse deliver medications to patients (Leapfrog, 2016).

External customers: People who buy healthcare services from the institution, i.e. patients (Joseph, 2012).

Internal customers: People who work within the company, i.e. staff, vendors, and anyone the institution has a partnership with who assists in delivery of healthcare in the institution (Joseph, 2012).

Medication Scanner or Barcode Scanner: A handheld apparatus that reads the barcode on medications in conjunction with the EMR (Leapfrog, 2016).

Refreeze: Instituting new behaviors and patterns (Kaminski, 2011).

Seven rights of medication: Quality indicator standards for medication administration. These include the right medication, the right patient, the right dose, the right time, the right route, the right documentation, and the right of the patient to refuse the medication being given (U.S Department of Health and Human Services, 2015).

Stakeholders: All persons that will be affected by instituted change.

Unfreeze: Changing current behavior patterns (Kaminski, 2011).

Relevance to Nursing Practice

This project was embedded in the broader problem of patient safety and medication errors. Errors attributed to medication administration are responsible for financial and human costs. It is estimated that 7,000 deaths per year occur due to medication errors (Chio et al., 2016). Healthcare costs have been estimated at $3.5 billion per year due to these preventable errors (Chio et al., 2016). This cost is only estimated for errors that are severe (Chio et al., 2016). Medication errors are a common occurrence in the hospital setting. These errors threaten patient safety. 6.5 medication error events occurred for every 100 patients. Over one quarter of the events were preventable errors (Chio et al., 2016). Patient safety is at the forefront of healthcare, and

is paramount with everything nurses do. Organizations such as JCAHO, CMS, strive to make healthcare safer for patients. Reducing medication errors through the use of technology (specifically BCMA) can increase the safety of patients.

Errors made during medication distribution to patients are one of the most common health-threatening patient care mistakes nurses make. This is a global and not just local problem. Medication errors result in one-fifth of hospital injuries (Mostafaei, Marnani, Esfahani, Estebsari, Shahzaidi, Jamshidi, & Aghamiri, 2012). Errors can increase length of stay in the hospital, mortality rates, and organizational healthcare-related costs. Reasons noted for medication errors included high nurse/patient ratios, noisy environment, fatigue, and carelessness. Reasons why nurses do not report errors immediately include fear of losing their job, reactions of the patient and family, and administrative penalties (Mostafaei et al., 2012).

BCMA use in conjunction with the eMAR can decrease the incidence of medication errors. The main professional goal of nurses is to help patients improve their health to their optimum functioning capability (Cheragi, 2013). The use of technologycan assist nurses in caring for their patients safely. Reporting medication errors is an important step in identifying a problem. It is recommended that nurses report all errors,both potential and actual, and nurse managers and administrators should view medication error reporting as a positive. When errors are reported, managers can pinpoint the problem and work to fix it. If nurses are afraid to report an error for fear of disciplinary action, they may not always report them. If errors are not reported, changes cannot be

made to improve patient safety. Use of BCMA is a recommended strategy to decrease medication errors.

The Institute of Medicine (IOM, 1999) said that medication errors were a very real and serious public health threat. The U.S. Food and Drug Administration agreed and in 2004 made it mandatory for barcodes to be placed on medications by 2006 (Wideman, Whittler, & Anderson, 2005). The motivation was a belief that over 500,000 adverse events could be prevented by using the barcode system (Wideman et al., 2005). Wideman et al., 2005, discussed that the 118-bed ICU at Harry S. Truman Memorial Veterans Hospital implemented then stopped the use of BCMA due to the lack of its functionality. After changes were made to the software programs the BCMA was reinstituted with better success. It was also mentioned that the key to success with the BCMA is communication between nursing and pharmacy.

This doctoral project attempted to fill a gap in practice in the perioperative area. Barcode scanners for medication administration are not currently used in the perioperative area. To elicit agreement of stakeholders and end users to begin using BCMA, a systematic review of the literature and subsequent dissemination of the evidence to stakeholders and end users was done. The evidence will be presented to stakeholders and end users showing the importance of using BCMA to reduce medication errors thus increasing patient safety.

Local Background and Context

Medication errors cause patient harm. This harm can range from a simple reaction to death. Patient safety is at risk whenever an error is made. There are many causes of

errors. The literature has listed some as noisy environments, interruptions during medication administration, carelessness of the person administering the medication, incorrect transcription of the order and fatigue (Cheragi, Manoocheri & Ehsani, 2013).

In the institution where this project was conducted BCMA is not utilized in the perioperative area. The reasoning is that it would encompass too many departments to initiate such a change and it would be difficult to implement due to the fast-paced nature of the department. To increase patient safety in the perioperative area by reducing medication errors, BCMA should be utilized. Literature has shown that using a BCMA system can decrease the amount of medication errors made. Use of BCMA can give nurses the peace of mind that a second check has been done to assure that the seven rights are honored thus decreasing the risk of an error occurring.

The setting in which the doctoral project took place was a nonprofit teaching community hospital with approximately 398 beds. The perioperative area serves approximately 30 -40 patients per day. Surgeries performed encompass general surgeries, orthopedic, neurological, renal, urinary and cardiac procedures. The use of the BCMA is already in use throughout the nursing units.

A board of directors to which administration reports governs the institution. The mission of the institution is to help everyone live a longer, happier, and healthier life. Their vision is to be a world-class leader of excellence in healthcare. Increasing patient safety in the perioperative area by decreasing medication errors through the use of BCMA fits into their mission statement and vision. When the systematic review findings

are presented the hope is that agreement from stakeholders will be elicited to institute the use of BCMA in the perioperative area.

There are state and local contexts that are applicable to this DNP project. One of the Joint Commissions' patient safety standards is to use at least two patient identifiers when providing care to patients. (NPSG.01.01.01: Joint Commission, 2015). The use of a BCMA falls under this context. The Agency for Healthcare Research and Quality standards also addressed the use of BCMA. They recommend that hospitals use a BCMA system along with the electronic medical record to decrease medication errors and increase patient safety (AHRQ, 2008).

Role of the DNP Study

I am currently a registered nurse with a master's degree in nursing education. I am also certified in gerontological nursing and a DNP student. My doctoral project was a systematic review to convince stakeholders to initiate BCMA use in the perioperative area. I did a systematic review of the literature and presented findings to the stakeholders. It is imperative that I continue to keep up with evidence-based practice and facilitate change using the available evidence. As a DNP student, I have the responsibility to provide leadership and education in order to create and sustain changes in line with evidence based practice. In addition, I also have a responsibility to recommend practice changes that can increase patient safety and enhance social change at my institution. I have a passion for my doctoral project because I work in the perioperative area. We give medications such as Intravenous Versed, Fentanyl, Zofran and antibiotics as well as oral medications. I have seen errors made due to sound alike drugs, failing to chart that a

medication was given, reading the order incorrectly, and giving the wrong dose. I saw this as a practice problem and wanted to help the nurses' practice by convincing leadership to institute the use BCMA technology in the perioperative area.

By briefly reviewing the literature I found evidence that the use of barcode scanners could in fact decrease the amount of errors that occur during medication administration. Currently the stakeholders and end users are not ready to institute the use of the BCMA system in the perioperative area. For this reason, I have done a systematic review of the literature to convince them of the need for implementation of this technology for patient safety. The only bias I have is that I want BCMA instituted in the perioperative area. I realize that I cannot make a change without first reviewing the evidence to support its use. Once the evidence was compiled I applied for a time slot during leaderships meeting to disseminate the information in hopes that the change will be made in the near future.

Summary

In Section 2, a review of the reasons this doctoral project can make a positive difference and the benefits of BCMA was presented. Lewin's change theory was discussed which guided the systematic review and presentation of the evidence. The gap in practice that this project addressed is the lack of BCMA use in the preoperative area. Section 3 will show the plan used to carry out this project.

Section 3: Collection and Analysis of Evidence

Introduction

This project focused on the lack of barcode scanner use in the perioperative area of a hospital. An eMAR along with barcode scanner is used throughout the institution except in fast-paced areas like the perioperative department at this community teaching hospital. The focus of this project was to present the evidence regarding BCMA use to elicit buy in from stakeholders regarding their need to institute BCMA scanners in the perioperative area to increase patient safety. Decreasing medication errors for patient safety was at the forefront of this project.

The need to address the problem lied in medication errors that could potentially harm a patient. Medication errors that are preventable still occur in hospital settings. A vital step in improving patient safety is to increase medication administration safety. According to the quality improvement (QI) department statistics at this hospital, there were seven reported medication errors in the perioperative area in 2017. Barcode scanning systems may be the answer to reduce errors. The problem that was identified is medication-scanning systems are not used in every department to deliver medication to patients. Specialty units such as the ER and perioperative services are among those areas that do not use scanners at this time. There was a lot of literature to substantiate using barcode scanners to reduce medication errors. Having a better understanding of the evidence behind using barcode scanners in conjunction with the eMAR may assist institutions in making decisions regarding their use in perioperative services bypresenting the findings to the stakeholders.

This project holds significance for nursing practice because it increases patient safety. Using barcode scanners assists the nurse in making sure preventable errors such as proper identification of patient and medication are met before administration of medication. Errors can be caught and avoided before they reach the patient. Nurses can sometimes feel guilty when they make a medication error that can lead to a cascade of events (American Nurses Association, [ANA] 2012). The barcode scanner can decrease errors, thus decreasing nurses' emotional response to any errors that could potentially increase nurse retention and satisfaction.

The purpose of this systematic review project was to elicit buy in from the stakeholders and end users regarding the importance of using a BCMA in the preoperative area. After completing the systematic review of the literature, the evidence was shared with stakeholders so they will potentially make the decision to implement barcode scanners in perioperative services. At this time, the thinking of the institution is that too many departments will be affected if barcode scanner use is started in the perioperative area. The reasoning is that it would encompass too many departments to initiate such a change and would be difficult to implement due to the fast-paced nature of the department. The gap in practice this project addressed was that perioperative services are one of the only areas in the institution that do not use this technology for patient safety. This project has the potential to close the practice gap by showing stakeholders and end users the patient safety issues attached to medication errors. If organizational leadership decide to institute the use of barcode scanners and medication errors are decreased, patient safety will be increased.

The first phase was to collect the evidence using different databases with chosen search words or phrases. After collection of the literature and analysis of the evidence and its pertinence to the project, a systematic review was completed. Upon completion of the systematic review, evidence was presented to the appropriate people to elicit buy in for them to institute the use of BCMA in the chosen area of practice. In this section, the plan used to carry out this project will be presented.

Practice-Focused Question

The local problem is that BCMA scanners are not used in the perioperative department of a community hospital. These scanners are used throughout the institution, except in high-volume fast-paced areas. The gap in practice is that these medication administration systems are used to help reduce medication delivery errors and increase patient safety, but not in this institutions' perioperative department. Not using the BCMA system could increase medication errors and decrease patient safety. The practice-focused question for this project is: In perioperative services does using a medication barcode scanning system to administer medications decrease medication errors compared to not using a barcode administration system to administer medications and thereby increase patient safety?

The purpose of this project was to elicit buy in from the stakeholders and end users as it relates to barcode medication scanner use in the perioperative area through a systematic review and dissemination of the evidence to stakeholders. This process aligns with the practice-focused question by showing them how BCMA can increase patient safety by reducing medication errors.

Sources of Evidence

Primary sources of evidence used for this systematic review process included: peer-reviewed articles, previous systematic reviews, and observational studies. These sources were obtained from Walden University's library databases including CINAHL Full Text, Pub Med, Ovid Nursing Journals Full Text, Google Scholar, and ProQuest. Collection and analysis of data from the primary sources of evidence were compiled into a systematic review. The sources reviewed related to barcode medication scanners at point of care and their use to increase patient safety by decreasing medication errors. The purpose of this project described in Section 1 was to educate and elicit buy in from stakeholders regarding the need for barcode scanner use in the perioperative area. The sources of evidence used allowed the completion of a systematic review that will educate the stakeholders so they will potentially choose to institute BCMA scanner use in the perioperative area. The translated evidence obtained through a systematic review was then presented to the stakeholders. Systematic review of the evidence followed by dissemination of the evidence to stakeholders was the most appropriate way to educate and elicit buy in from them to institute BCMA use in the perioperative area.

The advanced search features of databases allowed for a thorough search of existing evidence, allowing a methodical investigation of the literature to be conducted.. Keywords and phrases that were used were: *barcode medication administration, BCMA medication errors, BCMA use in perioperative services, safe medication administration,* and *medication administration in surgery*. All literature in the review was published

between 2013 and 2018. Sources used were systematic reviews, integrative reviews, observational studies, and peer-reviewed articles.

This literature review was exhaustive and comprehensive. All articles reviewed that were published between the years 2013 and 2018 were assessed for their appropriateness to the project. Once the articles that pertained to this project had been isolated, an in-depth systematic review was carried out.

There were no ethical issues for this project. No human subjects were used in this systematic review project. Evidence was presented to the management team of the organization.

Analysis and Synthesis

The available evidence was reviewed, analyzed, and synthesized to create a systematic review. The findings of the systematic review were translated into evidence that was disseminated to the stakeholders of this institution. The JHNEBP model tool kit was used (see Figure 2).

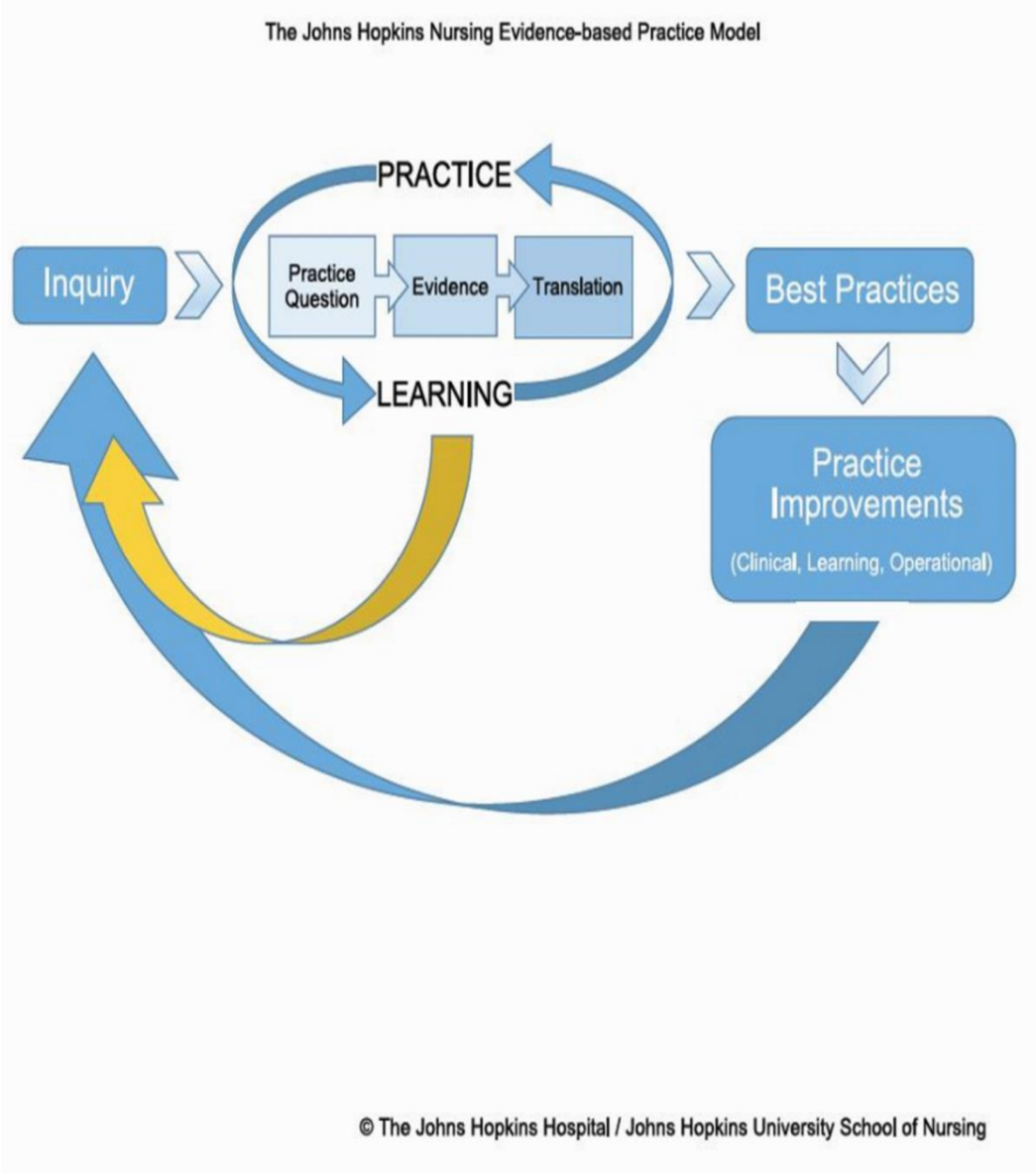

Figure 2. 2017 Johns Hopkins nursing evidence-based practice model.http://www.Johns Hopkins Nursing Evidence Based Pratice.com

The evidence-based table from the toolkit allowed ease of tracking, recording, and organizing data. The information that was input includes: a) database retrieved from b) author and date c) evidence type d) sample size e) findings that help answer the EBP

question f) limitations, and g) evidence level and quality. An evidence-based table is used to present data and generally has seven to ten columns (University of North Carolina, 2017). Once the information is included in the table the researcher can easily see any differences or similarities that arise in the literature reviewed (Susan G. Komen, 2015). This systematic review project benefitted from the use of this evidence-based table due to its ease of referencing the literature and its content.

The integrity of the literature used was assured by using only primary resources, systematic reviews and peer-reviewed articles. Each article was thoroughly reviewed to assess for inclusion and exclusion criteria. Each article was analyzed for its applicability to the project question utilizing an evidence-based table. The literature was appraised utilizing The John Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool. This tool served as a guide to properly identifying each articles evidence level and quality rating. Each article that was reviewed was categorized using its identified level of evidence and quality rating as specified by the John Hopkins Tool. Before using the tool, permission was obtained from the Institute for John Hopkins Nursing. Information gained from each article using the John Hopkins tool was put into the evidence-based table for ease of information review and retrieval.

Summary

Section 3 focused on what was done in this systematic review project. The literature was reviewed to ascertain the benefits of using a BCMA system and its impact on patient safety. The John Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool and its importance to this project were discussed. The problem

question is: In perioperative services does using a medication barcode scanning system to administer medications compared to not using a barcode administration system to administer medications decrease medication errors therefore increasing patient safety? The following sections will address how the project unfolded in terms of research done and findings.

Section 4: Findings and Recommendations

Introduction

Approximately 7,000 people die each year due to medication errors (Agency for Healthcare Research and Quality, nd). Medication errors cost approximately $2,000-$8,750 per error (Anderson & Townsend, 2015). JCAHO has identified a list of high-alert medications which are thought to have a high risk for causing patient injury. Drugs on this list include but are not limited to anticoagulants, chemotherapeutic agents, and narcotics. Although this list is important, all medications have the potential to cause patient harm (Anderson & Townsend, 2015).

The local problem and gap in practice that was identified is the underuse of available BCMA technology to provide safe medication administration to perioperative patients. The only areas in the chosen institution that do not use this technology are perioperative services and the emergency department. The practice focused question that drove this project was: In perioperative services, can using a medication barcode scanning system to administer medications decrease medication errors compared to not using a barcode medication administration system, and thereby increase patient safety? The purpose of this project was to conduct a systematic review of the literature regarding the usefulness of a BCMA system in reducing medication errors therefore increasing patient safety. Through this systematic review and findings dissemination, it is hoped that leadership will choose to follow evidence-based practice and implement BCMA use in this area.

Sources of Evidence

The sources of evidence used for this systematic review were: one systematic review, one integrative review, and six before and after observational studies. Articles were retrieved from databases including: CINAHL with full text, MEDLINE with full text, PubMed, ProQuest, and Ovid Nursing Journals full text. All articles were full text in the English language. The studies related to medication error rates with and without the use of a BCMA system. Search terms used were *BCMA, perioperative medication errors, BCMA medication errors, Perioperative BCMA, BCMA technology, surgical BCMA use, and medication errors in surgery BCMA.*

In order to appraise and evaluate the strength of the scientific data obtained from each article, the JHEBP tool kit was used (see Appendix B). Permission was obtained to use the JHEBP tool kit (see Appendix C). All scientific data taken from each article went through a comprehensive and exhaustive review. The first step to each article review included appraising the level and quality rating of each study. Depending on the findings in step one, the model guided the appraisal of the articles evidence to the next step.

Findings and Implications

Data was taken from each article with the use of the JHNEBP model tool kit and put through an exhaustive process. This process consisted of appraising the level of the evidence or study design and completing a quality appraisal of each research study. For the systematic review articles, a quality appraisal of each systematic review with or

without metanalysis was used. After completion of the appraisals, each study's quality rating was ascertained.

The first literature search limited to sources with publication dates between 2009 and 2018 resulted in 1,540 articles; 987 articles were excluded after abstracts were reviewed due to lack of data relating to BCMA use and medication errors at point of care (see Appendix D). Articles that were excluded focused on transcription, physicianordering, and those that had no bearing on barcode medication administration but used the acronym BCMA, and 237 articles were excluded due to lack of availability of full text. The medical library at the chosen institution was consulted for full-text articles when full text was not available in databases. The original 9-year publication framework was narrowed to a 5-year publication search to assure that only the most up to date evidence was used. With the narrowed publication dates, 308 more articles were excluded. The remaining eight articles met inclusion criteria.

Inclusion criteria for this systematic review were as follows: a) a publication date between the years 2013 and 2018, b) subject matter pertaining to barcode medication administration at point of care and/or medication errors in a perioperative setting, c) presence of before and after BCMA implementation data with the use of only adult subjects, d) presence of full text, e) English language, and f) hospital setting. Only English language articles were included due to the lack of resources to translate non-English articles into the English language.

Each of the eight studies clearly presented its purpose as well as strengths and limitations. Tables and graphs in each study had an explanatory narrative. Most of the

literature reviewed for the systematic review was current and published within the last 5 years. The systematic review articles included key words and terms used. These key words and phrases were aligned with this reviewer's list of keyword and phrases.

Below is a detailed discussion of the findings from each of the articles that met criteria (see Appendix A). Each article reviewed is identified by their level of evidence, quality level, and a brief summary of their findings is mentioned.

Detailed Discussion of Findings

Shah et al., 2016, evidence level 1, quality level B, conducted a systematic review utilizing three direct observational studies that used a prospective before and after design to examine the difference in medication error rates. The conclusion of two of the three studies was that the use of BCMA did reduce the absolute rate of medication errors by 4.6-4.7% at the point of care when timing errors were excluded. The third study did notreport findings for timing and non-timing medication administration errors separately.

Strudwick et al., 2018,evidence level I, quality level A, was an integrative review that utilized eleven studies where the authors reviewed the effect of BCMA technology on medication errors and factors associated with medication errors. Only two of the studies included in this integrative review focused on point of care BCMA use and medication errors. The remaining studies focused on nurse scanning rates and factors associated with medication safety. The two methods of data retrieval that were used were direct observation of medication administration and analysis of medication administration errors from incident reports retrospectively on all of the studies. Two studies did not see a reduction in medication errors. One study noted an increase in errors with no specific

error type accounting for the increase and one found a decrease only when wrong time errors were eliminated. Overall the conclusion of the authors was that BCMA systems are an effective technology for decreasing medication errors in the acute care medical environment.

The remaining studies (n = 6) in the integrated review had similar findings related to medication administration errors at point of care before and after BCMA implementation. One nonequivalent comparison group observation with pre and post-test, one prospective observational study, two naïve observational studies, and two before and after studies were included in this systematic review. Each of the studies assessed the rate of medication errors before and after implementation of a BCMA system at point of care. The findings of five of the studies indicated that medication errors were decreased with BCMA use with a consensus that errors were not completely eliminated. One study recommended the implementation of process and technology-based solution.

Seibert et al., 2014, evidence level II, quality level A, was a pretest-posttest nonequivalent comparison group study. The accuracy rates of medication administration were observed before BCMA implementation then again six and twelve months after BCMA implementation. Observation results were:

Hospital 1 Phase 1 to Phase 3:

- Accuracy rate increased from 89% to 90% (p=0.0015)
- Accuracy rates increased from 92% to 96% (p=0.00008) with wrong time errors excluded).

Hospital 2 Phase 1 to Phase 3

- No significant changes in accuracy rates that included wrong time errors
- Accuracy rate went from 93% to 96% (p=0.015) excluding wrong time errors

When unit specific percentages were broken down the data showed that there was an increase in medication accuracy rates in all areas after the implementation of the BCMA eMAR system. Their final conclusions show that preventable errors were reduced significantly with the use of a BCMA e-Mar medication administration system.

Bonkowski et al., 2013, evidence level II, quality rating A, is a naïve observational study done at an academic medical center. This study discussed the importance of a BCMA technology to help prevent medication errors in a hospital setting. Their results showed that there was an 80.7% relative rate reduction related to the administration of medications and subsequent errors with the use of a BCMA system ($p < 0.0001$). The only specific error type to reach significance in this study was wrong dose errors. These errors had a 90.4 relative rate reduction (RRR) ($p < 0.0001$) The RRR for a wrong drug error was 100% ($p = 0.5$), no drug order 72.4% ($p = 0.057$) and wrong route errors 36.8% ($p = 0.58$). The findings of this study conclude that implementation of a BCMA in the ED is associated with decreased medication administration errors.

Bonkowski et al., 2014, evidence level II, quality level A, was a naïve observational study. Their findings were that BCMA implementation resulted in a relative reduction rate of 68%. BCMA reduced wrong dose errors by 67%, which was the only error type to show a significant reduction rate.

Nanji et al., evidence level II, quality level B is a prospective observational study. The findings were that 1 in 20 perioperative medication administrations and every second operation resulted in a medication error or an adverse drug event, 1/3 of the errors had observed patient harm with the remaining 2/3 having potential patient harm. Recommendations were to target the creation and implementation of process-and-technology based solutions.

Truitt el al., 2016, evidence level II, quality level B is a before and after BCMA implementation study. The rate of ADEs significantly decreased from 0.26% to 0.20% after implementation of the technology (Relative risk [RR], 0.78; 95% CI, 0.67-0.89). The rate of administration errors was identical in both groups at 0.017%.

Risor et al., 2016, evidence level I, quality level A, was an observational study. Their findings were that the medication error rate decreased from 0.35 at baseline to 0.17 at follow up in the intervention ward and from 0.37 to 0.35 in the control ward. Overall risk of errors was reduced by 57% in the intervention ward compared with the control ward (OR 0.43; 95% CI 0.30 to 0.63). Conclusion: The automated medication system reduced the error rate of the medication administration process and thus improved patient safety.

Strengths/Limitations

One strength of this systematic review is that the evidence shows the ability of a BCMA system to reduce medication errors in the clinical setting. Another strength is that the BCMA system is in place and used in other areas of the hospital. Hopefully with these findings it will strengthen the argument to bring BCMA into the perioperative area

that prior to the systematic review were not available to present a strong and validated argument to initiate BCMA in the perioperative area.

One limitation of this study is that six of the eight included articles (n=6) were observational studies, which could be affected by the Hawthorne effect. The Hawthorne effect is a term used to describe how people behave differently and tend to perform better when they know they are being observed, however this behavior may subside once the subjects are comfortable being observed. In relation to search methods one limitation is the restriction of the search to only English language articles. This was a limitation because the researcher had no available resources to translate articles not published in the English language.

Another limitation is that for some, bias may be a concern. As the sole student and evaluator of the articles, a concern that bias may exist or articles could be missed. However, using the John Hopkins Tool for a systematic review does not require another reviewer or the use of a librarian, which is common in other models utilized for systematic reviews. The John Hopkins Toolkit was used according to recommendations and procedures and they were followed as advised (Appendix B). Moving forward, if I plan to publish I will enlist the aid of another colleague or the library at my clinical institution. This project has set the foundation and the framework to be able to conduct a systematic review in the future.

Implications for Social Change

Implications for social change resulting from the findings in this systematic review fall under patient safety. Each article in the review found that the use of a BCMA system can reduce medication errors but not completely eliminate them (Appendix A). By reducing medication errors patient safety is increased. This systematic review supports the use of a BCMA system in the perioperative area. The use of a BCMA system can increase patient safety by supporting the nurse in assuring the six rights are checked before medication administration.

Another implication for social change is nurse empowerment. The initial approach was discussed without EBP and literature to support the change and a "No" was awarded from administration. They will instead consider the use of a more direct,educated and thought-out approach with EBP to support their stance on the proposed change in question. In order for nurses to find their voice and become scholars of change, this process provides a method that can be utilized to assist the nurses to be more successful as a change agent.

Recommendations

Technology advancements occur in healthcare at a steady rate. Due to these advancements it is crucial that leadership including managers, directors and upper management take the lead in unearthing and sharing the latest evidence-based practice that shows best practice for the use of BCMA use in the perioperative area. In the chosen institution there are shared decision-making councils. These councils include service line

councils, a research council and a practice council among others. Leadership should bring their evidence to the practice council, which would then send it to the appropriate council to be instituted. This systematic review shows that more research needs to be conducted regarding the use of a BCMA system in the perioperative area and its effects on medication errors in this fast-paced area.

Section 5: Dissemination Plan

The plan to disseminate the findings of this systematic review begins with addressing the target audience for this intended DNP project. The initial project was to implement the BCMA in the chosen setting and was rejected at first approach. The systematic review was selected to show the stakeholders that BCMA has value and use in the perioperative setting. A presentation to the leadership of the chosen institution will be given on the benefits of BCMA at the conclusion of my DNP journey. Leadership includes the chief nursing officer, chief financial officer, manager, and director of the perioperative area, as well as the director and manager of the pharmacy department. The presentation to leadership will be done during one of their leadership meetings. Thisvenue was chosen because all leadership stakeholders will be present, allowingdissemination of the findings to be given to all at the same time. The presentations willtake place after permission to do so is obtained. The audience is appropriate fordissemination of the findings since they are the stakeholders and will make the decisionwhether BCMA use will be instituted in the perioperative area.

Analysis of Self

Scholar

The characteristics of a scholar identified by Tolk (2012) to be essential are:

- Ethics: A scholar has strong professional ethics.
- Immersion: A scholar familiarizes themselves with both classic and up to date literature in their area of inquiry.

- Disposition: A scholar has academic poise, skepticism concerning knowledge claims, and is able to self-criticize.
- Authority: A scholar can be articulate about their area of inquiry.
- Persistence: A scholar shows resoluteness seeking deep explanations of events.
- Passion: A scholar has a passion for their area of study that emanates to others.

These characteristics were listed to be greater than 80% essential for scholars (Tolk, 2012).

This systematic review gave me the opportunity to show myself that I possess the characteristics needed to be a scholar. The process of identifying the practice problem and creating the evidence-based practice question sparked a passion in me about the subject of BCMA use to increase patient safety. Evaluating the evidence using the JHNEBP model tool kit allowed me to test the strength of others' research. Throughout this project's evidence retrieval process, I have gained knowledge that I am able to articulate to others.

Student

Reflecting on my journey through this project, courses, and practicum, I can see I have grown professionally. I have gained a newfound understanding of the need to use evidence-based practice when contemplating making a change in practice. My courses have taught me about leadership styles, allowing me to critically assess myself and my current style of leadership. I now understand my own leadership style and have an

understanding of what I need to change to be an effective leader. My journey through this project has taught me about the importance of appraising evidence and using high quality evidence to bring about change in my practice area. Critical thinking skills have been required during this journey and mine have been enhanced through the DNP project process. This journey has also shown me how difficult it can be to gain leadership approval for any project. Reflecting on my journey, I can see how my interpersonal skills have been enhanced as well as my communication, time management, and organizational skills. The development of all of these skills has been necessary to complete this program. As the chair of my shared decision-making council and member of two other councils, I have found the skills obtained during this program extremely helpful. During my practicum, I have learned about leadership's responsibilities to the institution and staff. I have learned about conflict resolution and data collection for existing matrix reports. I will, for the rest of my professional career, remain engaged in committees and organizations, allowing me to help with making needed practice changes that can help not only my institution but my community.

Summary

This doctoral project was a systematic review of the available evidence as it related to BCMA use in the hospital setting. This project was undertaken to show the leadership of the chosen institution the importance of using a BCMA system for patient safety during medication administration, particularly in the perioperative department. The message the evidence brought forth is that the use of a BCMA system can decrease medication errors, thus increasing patient safety. After dissemination of the findings of

this systematic review, it is hoped that leadership will choose to institute this technology in the area not currently utilizing BCMA.

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Appendix A: Individual Evidence Tool

EBP Question: In perioperative services does using a medication barcode scanning system to administer medications decrease medication errors compared to not using a barcode administration system to administer medications and thereby increase patient safety?						
Article Number	Author and Date	Evidence Type	Sample, Sample Size, Setting	Findings That Help Answer the EBP Question	Limitations	Evidence and Quality level
1	Shah, K.,Lo, C.,Babich,M., Tsao,N.,Bansback, N . 2016	Systematic Review	5 studies used	. BCMA non-timing errors decreased from 11.5 to 6.8%. This is a 41.4% relative risk reduction (RRR) and a 95% confidence interval (CI). BCMA reduced errors resulting in administration of a wrong dose or wrong medication and wrong route.	Unable to assess publication bias, only English language articles used	I B *Table Continues*
2	Seibert,H.,Maddox,R.,Flynn,E.,Williams, C. 2014	Non equivalent comparison group Observation with pre and post test	St.Josephs/Candler Health System=2 tertiary care hospitals with a total of 644 beds	Improvement in medication accuracy rates were seen in adult inpatient units. The frequency of errors preventable by BCMA-eMAR decreased significantly in both hospitals after implementation of the technology	Included observation on units where no other data was available and comparative data was from different methodologies.	II A
3	Nanji, K.,Patel,A.,Shaikh, S.,Seger,D.,Bates,D. 2016	Prospective Observational Study	A 1,046 bed tertiary care academic medical center.Academic hospital operating room. 277 operations requiring general anesthesia,74 anesthesiologists,51 CRNA's and 101 house staff were observed	1 in 20 perioperative medication administrations and every second operation resulted in a medication error or an adverse drug event1/3 of the errors had observed patient harm with the remaining 2/3 having potential patient harm. Recommendations were to target the creation and implementation of process-and-technology based solutions	Potential Hawthorne Effect,	II B

4	Bonkowski, J., Carnes, C., Melucci,J.,, Mirtallo,J.,,Prier,B., Reichert,E.,Moffat-Bruce 2013	Naïve Observational study	Medication administrations observed-996 pre BCMA and 982 post BCMA implementation. Study done at an academic medical center that was implementing BCMA in the emergency department.	Significant reduction in medication errors with BCMA use.	Possible Hawthorne Effect.	II A
5	Bonkowski,J., Weber, R.,Melucci,J., Pesavento,T., Henry, M.,Moffot-Bruce,S., 2014	Observational study	936 medication administrations observed before and 976 medication administrations were observed after implementation at an academic medical center solid organ transplant unit.	BCMA implementation resulted in a relative reduction rate of 68% .BCMA reduced wrong dose errors by 67% which is the only error type to show a significant reduction rate	Possible Hawthorne effect	II A
6	Strudwick.G.,Reisdorfer,E.,Warnock, C.,Kalia,K.,Clark,C., Booth, R.,2018	Integrative review	11 studies were used	The results of this review indicate that BCMA systems are an effective technology toward reducing medication errors in the acute care medical environment when factors associated with medication safety are present. Two studies found that there were no change in medication error rate	Time frame used for data collection before and after bcma implementation varied in each study reviewed	1 A

Table Continues

7	Risor, B., Lisby, M., Soren s en, J. 2016	Controlle d before and after study	2245 observed medication administrations between control and intervention wards	The error rate decreased from 0.35 at baseline to 0.17 at follow up in the intervention ward and from 0.37 to 0.35 in the control ward. Overall risk of errors was reduced by 57% in the intervention ward compared with the control ward (OR 0.43; 95% CI 0.30 to 0.63). Conclusion: The automated medication system reduced the error rate of the medication administration process and thus improved patient safety.		1 A
8	Truitt, E., Thomp son,R., Blazey Martin ,D.,Ni Sai,D., Salem, D. 2016	Before and after study	Electronic error-reporting system reports were included in this study. 397 (51%) in pre-implementation period and 378 (49%) in post-implementation phase	The rate of ADE's significantly decreased from 0.26% to 0.20% after implementation of the technology (Relative risk [RR], 0.78; 95%CI, 0.67-0.89The rate of administration errors was identical in both groups at 0.017%.	Incident reports are reliant on the initial reporter in making an accurate report. Data used from incident reports is a small representation of actual errors	2 B

Appendix B: JHNEBP Tool Kit

- Appendix A: PET Management Guide
- Appendix B: Question Development Tool PICO
- Appendix C: Stakeholder Analysis Tool
- Appendix D: Evidence Level and Guide
- Appendix E: Research Evidence Appraisal Tool
- Appendix F: Non-Research Evidence Appraisal Tool
- Appendix G: Individual Evidence Summary Tool
- Appendix H: Evidence Synthesis and Recommendation Tool
- Appendix I: Action Planning Tool
- Appendix J: Dissemination Tool

Citation for tools: Dang, D., & Dearholt, S. (2017). *Johns Hopkins nursing evidence-based practice: model and guidelines.* 3rd ed. Indianapolis, IN: Sigma Theta Tau International. Retrieved from https://www.hopkinsmedicine.org/evidence-based-practice/ijhn_2017_ebp.html

Appendix C: Permission to Use JHNEBP Tool Kit

JOHNS HOPKINS NURSING EVIDENCE-BASED PRACTICE MODEL AND TOOLS

HERE ARE YOUR JHNEBP TOOLS (AND A SURPRISE GIFT)!

Thank you for your submission. We are happy to give you permission to use the JHEBP model and tool in adherence of our legal terms mentioned noted below:

- You may not modify the model or the tools without written approval from Johns Hopkins.
- All reference to source forms should include "©The Johns Hopkins Hospital/The Johns Hopkins University."
- The tools may not be used for commercial purposes without special permission.
- If interested in commercial use or discussing changes to the tool, please email ijhn@jhmi.edu.
  Click **HERE** to access the zipped file of the tools.

Please note: If you choose to use the Johns Hopkins Nursing Evidence-Based Practice Model and Tools in any other way, another form will need to be submitted.

Appendix D: Model of Study Numbers and Their Management