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The Efficacy of Barcoded Medication Administration in the Emergency Department

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Walden University

College of Nursing

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Aleksandr Vasserman

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
2022

Abstract

The Efficacy of Barcoded Medication Administration in the Emergency Department

by

Aleksandr Vasserman

MSN, Walden University, 2016

Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Nursing Practice

Walden University

December 2022

Abstract

The practice problem addressed in this Doctor of Nursing Practice project was safe medication administration in the emergency department (ED). Paper-based delivery of medication administration is prone to errors and multiple points of failure affecting patients' safety. The gap in nursing practice was the lack of analysis regarding the efficacy of the barcoded medication administration (BCMA) process in the ED. The practice-focused question for this project addressed whether the implementation of BCMA in the ED effectively reduced medication administration errors as compared to the previously used paper-based, non-BCMA process. The aim of this doctoral project was to review the efficacy of BCMA technology in the ED by comparing adverse drug event rates before and after BCMA implementation. Lewin's change theory was used as the framework to evaluate the change management that occurred before, during, and after BCMA implementation. The findings and retrospective analysis for this project demonstrated a significant reduction in medication errors post implementation by 68% ($p = .024$) during the initial 6 months and 63% ($p = .027$) 1-year post implementation, which indicates sustainability of the technology. Therefore, the recommendation based on these findings is for EDs to implement BCMA technology to reduce patient harm related to medication errors. This project has implications for positive social change, in that it may minimize patient harm related to medication errors and close a gap in nursing practice concerning the use of BCMA.

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Dedication

This dissertation work is dedicated to the memory of my mother, Evelina Katsenovich, MD, who lived selflessly while helping others.

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I would like to acknowledge Dr. Julibeth Lauren for her immense clinical expertise, thoughtful guidance, caring support, and never-ending inspiration during this project. My sincere and profound gratitude goes to Dr. Anna Valdez for strongly supporting this project while challenging me to amply utilize research principles and meaningful evaluation criteria.

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Section 1: Nature of the Project

Introduction

With the rise of health care information technology (HIT), there has been an increased focus on improving patients' safety and optimizing individual outcomes (Furukawa et al., 2017). Unfortunately, adverse drug events (ADEs) remain a substantial problem for acute care hospitals and account for an estimated 30% of all hospital adverse events, affecting almost 2 million hospital stays per year (Kuklik et al., 2019). With the growing body of research describing the devastating quality and financial impacts of medication errors, there is a bigger emphasis on the "do no harm" barcoded medication administration (BCMA) process (Strudwick et al., 2018). The purpose of this project was to evaluate successful strategies for translating new evidence into clinical practice by examining the efficacy of the BCMA in emergency department (ED) settings in reducing ADEs. A comprehensive analysis of pre- and post-BCMA ADE data was leveraged as a quantitative analysis for this project.

With a global COVID-19 pandemic deeply affecting millions of Americans, the Walden University commitment to social change is as crucial as ever. For those in the nursing profession, the everlasting drive to have a positive impact on the communities that they serve is undoubtedly connected with leveraging the latest technology to improve patient safety and improve individuals' outcomes. Safe medication administration should no longer be a luxury, but rather a required standard of care in hospitals across the nation. Moore et al. (2020) argued that advances in HIT applications are the driving force behind the social changes needed to enable access to quality care for all Americans.

Technological advances, such as telehealth, clinical decision support, and BCMA tools, enabled unprecedented access to quality care for thousands, especially in remote and rural areas. Consequently, with the growing body of research indicating the significant effects of BCMA technology on reducing ADEs and improving patients' safety, there is a critical need to enable widespread use of such life-saving technology (Moore et al., 2020).

From the days of Florence Nightingale, one of the most considerable nursing practice tasks was medication administration (Moore et al., 2020). While the nursing profession advanced significantly since its early days, the aim to prevent patients from experiencing any harm remained a constant ethical obligation for generations of nurses worldwide (Kuklik et al., 2019). In the increasingly multifaceted health care environment, there is an increased risk of medication errors due to higher patient acuity, multiple comorbidities, and the complexity of nursing workflow (Van der Veen et al., 2020). Not surprisingly, there are far-reaching implications for nursing practice in preventing ADEs by leveraging BCMA applications and casting a safety net of technology to eliminate patient harm. Consequently, this project's aim is to positively affect social change by evaluating the efficacy of BCMA technology in reducing ADEs and ultimately providing a safety net for better patient safety in the community.

Problem Statement

The evidence-based practice project addressed the significant practice problem of one organization's high potential for medication errors in the ED setting. The practice problem warranted the use and subsequent evaluation of evidence-based technology, such

as BCMA, to promote patient safety and decrease the rate of medication errors. Furukawa et al. (2017) emphasized that medication errors and associated ADEs could increase hospital length of stay by as much as 30% while triggering harmful short- and long-term individual patient outcomes. Despite major advances in medicine and technology, medication administration errors continue to increase, leading to adverse outcomes, potentially serious patient harm, and costs in the billions of dollars to health care organizations, which constitute a potentially preventable financial burden (Moore et al., 2020). Furthermore, almost 7,000 lives are lost every year in the United States due to medication errors (Kuklik et al., 2019).

Medication errors can potentially occur during the ordering process (56%), while orders are transcribed (6%), as medications are dispensed (4%), and during actual medication administration (34%; Furukawa et al., 2019). The latest data analysis also indicates that in-hospital rates for medication errors could range from 2% to 7% of all admitted patients, indicating a widespread practice problem (Moore et al., 2020). Similarly, the project site's medication error rate was reported to be 6%. BCMA is usually described as an electronic, real-time clinical decision support application aimed to establish and ensure the fundamental "rights" of medication administration: right patient, right medicine, right dose, right route, right time, right documentation, right patient education, and right to refuse (Van der Veen et al., 2020). The BCMA application validates the medication administration process against electronic health records (EHRs) by leveraging individually barcoded unit-dose medications as well as patients' barcoded armbands (Macias et al., 2018). Initially implemented in Veterans Administration

hospitals in the late 1990s, BCMA revolutionized the way in which nurses administer medications at the bedside while significantly improving patient safety (Moore et al., 2020). Furthermore, research indicated that BCMA technology decreased in-hospital medication errors by as much as 85%, reduced ADEs by 73%, improved documentation compliance, and led to enhanced patient safety (Truitt et al., 2016). The term *closed-loop BCMA* was described as the evidence-based standard of care and defined as the utilization of BCMA across the entire continuum of acute care, including ED, medical-surgical, intensive care, surgical services, women's health, and other areas (Furukawa et al., 2019). Conversely, the intended outcomes of improving patient safety via BCMA technology cannot be fully realized if the medication administration process "loop" does not include critical components such as the hospital's ED or procedural areas (Van der Veen et al., 2020).

The practice problem of not using BCMA technology in the ED is widespread, with many South Florida hospitals affected. While the project site, a 250-bed acute community-based hospital, is known for its commitment to quality care and innovation, the initial BCMA rollout did not include the ED. In early 2018, the hospital's multidisciplinary BCMA Committee approved the initial rollout to all inpatient nursing units but excluded the ED. Similar to observations by Moore et al. (2020), the decision to exclude the ED was based on operational concerns of "complicated and fast-paced workflow" as well as significant budgetary constraints. Not surprisingly, the existing practice problem with medication errors in the project site ED persisted. Since the initial implementation of BCMA in the medical-surgical units, the ADE rates in the ED

increased by an additional 3.8%. Subsequently, the site's BCMA Committee reconvened to review the reported ADEs in the ED, which indicated consistently higher rates of ADEs per 1,000 medications given as compared to inpatient nursing units. Conversely, there was a significant decrease in reported ADEs (up to 60%) on the nursing units utilizing the BCMA 6 months after the rollout, as indicated in the performance improvement (PI) annual report. The increasing ADE rates in the ED presented a considerable patient safety concern, prompting an additional review of ED workflow, as well as the current literature, supporting the utilization of BCMA in the ED as a key factor in reducing medication errors (Strudwick et al., 2018). Consequently, the BCMA project scope was extended to include the ED in June 2019.

There is a growing consensus among the informatics community that while the BCMA process shows significant potential for eliminating ADEs, lack of unified federal and local standards of care as well as hospitals' financial constraints remain major barriers to wider adoption of this life-saving technology (Owens et al., 2020). This doctoral project holds significance for the field of nursing practice as it evaluated the efficacy of BCMA technology in reducing ADEs and improving the safe delivery of patient care in the fast, unpredictable, highly complex ED environment.

Purpose Statement

The identified gap in nursing practice is the lack of analysis regarding the efficacy of the BCMA process in the ED. The lack of quality improvement (QI) analysis was increasingly noticeable as many organizations implemented BCMA technology in medical-surgical and intensive care units while excluding the ED (Moore et al., 2020).

The much-needed change in basic assumptions from historically used paper-based medication administration toward real-time, electronic, BCMA technology has significant implications for nursing practice (Owens et al., 2020). The far-reaching effects of ADEs on patients' mortality and morbidity have been prompting acute hospitals to reevaluate the entire medication administration workflow. Furthermore, Furakawa et al. (2017) reported a substantial reduction in ADEs post-BCMA implementation in an acute care hospital. The researchers reported that the pre-BCMA ADE rate of 6.3% was reduced to 1.2% after implementing BCMA technology (Furakawa et al., 2017). These results represented a statistically significant ADE rate reduction of over 80%, leading authors to advocate for widespread nursing practice change to include BCMA in the ED.

Unfortunately, despite an increasing body of nursing research, less than 60% of American hospitals implemented the BCMA application across the entire continuum of care (Furakawa et al., 2017). There is a clear need for current nurse leaders to embrace the BCMA advocacy campaign while translating the available evidence into clinical practice. Furthermore, the goal of any clinician is to deliver the safest evidence-based care for patient populations (Moore et al., 2020). Thus, the emerging role of the informatics nurse is to drive clinical practice acceptance and adaption of closed-loop BCMA as an evidence-based practice standard of care. This DNP project enabled the quantitative evaluation of the BCMA-driven QI initiative in the ED by comparing the data for reported ADEs 6 months before and 6 months after BCMA implementation. Additional comparison ADE data were used for the January to June 2022 period and analyzed retrospectively.

Consequently, the guiding practice-focused question for this project was the following: Will the implementation of BCMA in the ED effectively reduce medication administration errors as compared to the previously used paper-based, non-BCMA process? The aim of this doctoral project was to review the efficacy of BCMA technology in the ED by comparing ADE rates before and after the implementation. Addressing the gap in nursing practice related to the evaluation of BCMA technology in the ED is of paramount importance for safe medication administration, especially in the move forward to new postpandemic care delivery and optimized workflows (Moore et al., 2020).

Nature of the Doctoral Project

To meet the purpose of the doctoral project, the retrospective data analysis compared ADE rates in the ED before and after BCMA implementation. ADEs are defined as preventable events in which a patient receives a dose of medication that is different from what was electronically prescribed by the provider, including missed doses (Strudwick et al., 2018). The data source used was the self-reported, web-based, electronic database used for ADE reporting (type and severity are required) by staff across the facility. Pre-BCMA implementation data were collected at a community-based hospital's 45-bed ED through a retrospective medication error data review for a 6-month period from December 2018 to June 2019 and compared with 6-month post-BCMA implementation ADE rates reported from August 2019 to February 2020. The deidentified reported medication errors data included medication name, route, dose, and

time of administration. The total number of medication errors per month was calculated and used for pre- and post-BCMA comparison and analysis.

The retrospective ADE analysis of reports was only conducted if the original medication administration was given in the ED during the defined timeframe. Furthermore, the ADE reports that did not fully contain the complete information (type of error and severity) were excluded. The total number of errors in medications administered in the ED during the defined time periods was used to compute the rate ratios of ADE per 1,000 medication doses given in the ED.

Preventable harm caused by the widespread errors associated with medication administration continues to present challenges across the globe (Millichamp & Johnston, 2020). Moore et al. (2020) warned that medication errors could cause catastrophic patient outcomes while costing hospitals billions of dollars in yearly spending. An astonishing 1.2 million ADEs occur annually in the United States, yet over 75% of them are preventable (Millichamp & Johnston, 2020). The purpose of the doctoral project was to evaluate the existing QI project by leveraging the quantitative pre- and post-BCMA data analysis of medication error rates.

Significance

A Gallup poll survey of the American public has consistently rated nurses as the most trusted group of professionals over the last decade (Owens et al., 2020). Upholding that trust and preventing ADEs during the medication administration process are of paramount importance for nursing professional practice. Moore et al. (2020) noted that with the increased focus on consumer-facing technologies, quality data on safe

medication administration are among the driving forces behind patients choosing one health care organization over another. Having lifesaving BCMA technology in the ED has led to optimized nursing practice, has significantly improved patient safety, and has often prevented harm (Millichamp & Johnston, 2020). Having BCMA technology in the ED not only enables electronic provider order entry, but also allows clinical validation by stakeholders, including clinical pharmacists, nurses, and respiratory technicians. The interdisciplinary stakeholders of the BCMA process include bedside nurses, leadership, PI and quality teams, as well as pharmacy and patient safety executives. Artificial intelligence and clinical decision support require the clinician to cross-check allergies, as well as drug–drug and drug–food interactions (Moore et al., 2020). Positive patient identification is one of the most significant safety components of BCMA, achieved by the nurse scanning the uniquely barcoded patient’s arm band before any medication can be administered.

In the increasingly multifaceted health care environment, there is an increased risk of medication errors due to higher patient acuity, multiple comorbidities, and complexity of nursing workflow (Van der Veen et al., 2020). The goal of the doctoral project was to support the efficacy of BCMA technology in the ED. Despite the increasing number of studies supporting BCMA technology in reducing errors in medication administration, there is a considerable lack of state and federal standards aimed at mandating this lifesaving technology (Moore et al., 2020). Consequently, there is high transferability of the doctoral project findings to other EDs with similar patient populations as well as to

inpatient practice areas such as medical-surgical, intensive care, oncology, and women's health, among others.

Moore et al. (2020) argued that advances in HIT applications are the driving force behind the social changes needed to enable access to quality care for all Americans. Technological advances, such as telehealth, clinical decision support, and BCMA tools, enabled unprecedented access to quality care for thousands while advancing the greater good. With the growing body of research indicating the significant effects of BCMA technology on reducing ADEs and improving patients' safety, there is a critical need to enable widespread use of such life-saving technology (Moore et al., 2020). The project's aim was to positively affect social change by leveraging evidence-based BCMA technology to improve the medication administration process, eliminate ADEs, reduce medication-administration-related errors, and ultimately provide a safety net for better patient safety in the community.

Summary

Preventing patients' harm is one of the longest standing yet extremely relevant goals of nursing practice (Moore et al., 2020). The complex, fast-paced, often unpredictable nature of many ED workflows presents multiple practice challenges for safe medication administration, which well describes the nature and significance of the practice problem reflected in this project. It is difficult to overestimate the relevance of safer medication administration to nursing practice. The purpose of this doctoral project was to evaluate BCMA technology as a potentially life-saving application reducing ADEs. Not leveraging the BCMA process in the delivery of medications in the ED poses

a significant gap in nursing practice and leads to potential patient harm. Conversely, the adoption of BCMA technology in the ED could greatly contribute to improved patient safety, reduce ADEs, and prevent serious financial setbacks for acute care hospitals (Owens et al., 2020). The significance of the practice problem reflected in the astonishing numbers of medication errors warrants the evaluation of BCMA as a technological innovation for reducing ADE rates (Moore et al., 2020). In the next section, I discuss the background and context for safer medication administration via BCMA technology. The project site was an acute not-for-profit community hospital that undertook the implementation of BCMA technology. Lewin's change theory is introduced as the theoretical framework for this project. Safe medication administration is one of the core principles of nursing practice, hence the significant relevance of this project in evaluating the effects of the BCMA application on ADE rates in ED settings.

Section 2: Background and Context

Introduction

The evidence-based practice project addressed the significant practice problem of errors during the medication administration process in the ED setting and the lack of QI data validating the efficacy of BCMA technology use in the ED. The goal of safe medication administration in a complex, fast-paced modern health care environment is of paramount importance to improved patient safety (Furukawa et al., 2019). Unfortunately, ADEs remain a substantial problem for acute care hospitals and account for an estimated 30% of all hospital adverse events, affecting almost 2 million hospital stays per year (Kuklik et al., 2019). Moreover, the latest data analysis pointed out that in-hospital rates for medication errors could range from 2% to 7% of all admitted patients, indicating a widespread practice problem (Moore et al., 2020). At the same time, health care technology innovations such as the BCMA have revolutionized the way nurses administer medications at the bedside while significantly decreasing in-hospital medication errors by as much as 85%, reducing ADEs by 73%, substantially improving documentation compliance, and ultimately enhancing patient safety (Moore et al., 2020). With the growing body of research indicating the significant effects of BCMA technology in reducing the ADEs and improving patients' safety, there is a critical need to enable widespread use and evaluation of such lifesaving technology.

Interestingly, the Leapfrog Group and the Veterans Administration's Center for Patient Safety pointed out BCMA as an important initiative that helps health care organizations improve patient outcomes (Douglass et al., 2018). Owens et al. (2020)

pointed out that successful BCMA implementations must include the ED, which is consistently overlooked due to staff resistance, fast-paced workflows, or financial concerns. The identified gap in the nursing practice is the lack of QI data for the BCMA process in the ED. The efficacy gap became increasingly noticeable after many organizations implemented BCMA technology in medical-surgical and intensive care units yet excluded the ED. Consequently, the guiding practice-focused question for this project was the following: Will the implementation of BCMA in the ED effectively reduce medication administration errors compared to the previously used paper-based, non-BCMA process? The aim of this doctoral project was to review the efficacy of BCMA technology in the ED by comparing ADE rates before and after the implementation. Addressing the gap in nursing practice related to the utilization and evaluation of BCMA technology in the ED is of paramount importance for safe medication administration, especially in the move forward to new, postpandemic care delivery and optimized workflows (Moore et al., 2020). The importance of this project for nursing practice as well as a formal change management framework, along with my role as a DNP student and change agent, will be explored in the following section.

Concepts, Models, and Theories

Years before the current unprecedented COVID-19 pandemic, rising costs, declining reimbursement rates, a nursing shortage, and an aging population were among the main forces prompting organizational changes in American health care (Owens et al., 2020). In the postpandemic world, it will be essential for nurse leaders to embrace transformational care innovations while understanding change process theories and using

effective, evidence-based change management strategies. One way in which successful organizations transform the delivery of care is to rely on the planned change process while applying knowledge and core values to reach new strategic goals (Mick, 2019). Lewin's change theory served as the framework for this doctoral project on organizational change and evaluation of BCMA technology. Based on the groundbreaking work of Kurt Lewin (1951), the classic change theory identifies three main phases of planned change: unfreezing, movement, and refreezing (Marquis & Huston, 2015). Further, a change agent is frequently referred to as an individual with knowledge of change theory and skills to manage change effectively (Mick, 2019). Often, unfreezing, the first phase of the change process, takes place when a change agent convinces other team members that change is needed or required. The second phase of planned change, movement, reflects the planning and implementation of change strategies while overcoming barriers and resistance (Marquis & Huston, 2015). The final phase of the planned change process, refreezing, follows the change agent's efforts to have new changes permanently embedded in the business process and re-establish a new status quo (Mick, 2019).

Interestingly, Lewin's theory also explains that driving forces (facilitators) and restraining forces (barriers) are simultaneously operating in any given system, maintaining equilibrium (Marquis & Huston, 2015). While introducing revolutionary HIT applications such as BCMA into American health care led to significant improvements in care delivery and enhanced patient safety, substantial financial and quality barriers are still preventing much broader adoption (Owens et al., 2020). Consequently, Lewin's

change theory could be used as the framework for the organizations seeking to implement HIT applications as a planned change. For any such planned change to occur, especially BCMA in the ED, the driving forces must overcome the existing restraining forces, creating an imbalance. There is significant alignment between Lewin's change theory and this doctoral project based on substantial resistance to BCMA technology in the ED. Having the informatics nurses as change agents challenging the status quo and convincing the others that change in paper-based medication administration methods is needed remains critical to project initiation and ultimate success (Mick, 2019). In addition, managing organizational change in the postpandemic health care environment requires an innovative if not formal framework in order to achieve sustained transformation of care delivery. Similarly, using Lewin's change theory, the project site leadership would methodically apply unfreezing, change application, and refreezing stages for switching from a paper-based to BCMA-driven medication administration process. Specifically, the refreezing phase would be used to evaluate the efficacy of BCMA in the ED by evaluating the rates of medication administration errors.

The BCMA technology described in this doctoral project is an electronic, real-time clinical decision support application aimed to establish and ensure the many "rights" of medication administration: right patient, right medicine, right dose, right route, right time, right documentation, and right patient education (Van der Veen et al., 2020). The BCMA application validates the medication administration process against EHRs by leveraging individually barcoded unit-dose medications as well as patients' barcoded armbands (Macias et al., 2018). Initially implemented in Veterans Administration

hospitals in the late 1990s, BCMA revolutionized the way that nurses administer medications at the bedside while significantly improving patient safety (Moore et al., 2020). Furthermore, research indicated that BCMA technology decreased in-hospital medication errors by as much as 85%, reduced ADEs by 73%, improved documentation compliance, and led to enhanced patient safety (Truitt et al., 2016). The term *closed-loop BCMA* refers to an evidence-based standard of care and is defined as the utilization of BCMA across the entire continuum of acute care, including ED, medical-surgical, intensive care, surgical services, women's health, and other areas (Furukawa et al., 2019). Conversely, the intended outcomes of improving patient safety via BCMA technology cannot be fully realized if the medication administration process "loop" does not include critical components such as the hospital's ED or procedural areas (Van der Veen et al., 2020).

Relevance to Nursing Practice

With the growing body of research describing the devastating quality and financial impacts of medication errors, there is an increased emphasis on the "do no harm" BCMA process (Strudwick et al., 2018). From the days of Florence Nightingale, one of the most considerable tasks in nursing practice has been medication administration (Maaskant, 2015). Although the nursing profession has advanced significantly since its early days, the constant aim to prevent patients from experiencing any harm has remained an ongoing ethical obligation for generations of nurses worldwide (Kuklik et al., 2019). In the increasingly multifaceted health care environment, there is an increased risk of medication errors due to higher patient acuity, multiple comorbidities, and the complexity

of nursing workflow (Van der Veen et al., 2020). Moreover, Furukawa et al. (2017) emphasized that medication errors and associated ADEs could increase hospital length of stay by as much as 30% while triggering harmful short- and long-term individual patient outcomes.

The current state of nursing practice in medication administration remains inconsistent, with many hospitals not leveraging lifesaving BCMA technology (Owens et al., 2020). Despite significant advances in medicine and technology, medication administration errors continue to increase, leading to adverse outcomes, potentially serious patient harm, and billions of dollars of preventable financial burden (Moore et al., 2020). Furthermore, almost 7,000 lives are lost every year in the United States due to medication errors (Kuklik et al., 2019). Medication errors can occur during the ordering process (56%), while orders are transcribed (6%), as medications are dispensed (4%), and during actual medication administration (34%; Furukawa et al., 2019). The data analysis also pointed out that in-hospital rates for medication errors can range from 2% to 7% of all admitted patients, indicating a widespread practice problem (Moore et al., 2020). To improve safe medication administration practice, Owens et al. (2020) recommended wider adoption of BCMA technology along with electronic medication administration record-based clinical decision support. Recent landmark studies revealed that BCMA technology decreased in-hospital medication errors by as much as 85%, reduced ADEs by 73%, improved documentation compliance, enhanced superior patient education, and led to decreased readmissions and enhanced patient safety (Truitt et al., 2016). Furthermore, Furakawa et al. (2019) reported a substantial reduction in ADEs post-

BCMA implementation in an acute care hospital. The researchers noted that the pre-BCMA ADE rate of 6.3% was reduced to 1.2% after implementing BCMA technology. These results represented a statistically significant ADE rate reduction of over 80%, leading authors to advocate for widespread nursing practice change to include BCMA.

Alternative methods were used in the past to improve the safety of medication administration by requiring two nurses to witness, check, and cosign a paper-based process (Seibert et al, 2014). Additionally, staff education and high-risk medication lists were leveraged by acute care hospitals striving to reduce ADE rates in the last decade (Kuklik et al., 2019). Regretfully, none of the interventions aimed to improve paper-based medication administration were able to significantly decrease ADEs, primarily due to “the human error” factor being an inherent part of manual medication administration in a highly complex, fast-paced, full-of-distractions care environment (Strudwick et al., 2018). Furthermore, hospitals struggling with financial resources attempted to limit BCMA technology to inpatient units only, which led to inconsistent processes, prevented accurate electronic medication administration records, and often led to adverse outcomes for ED patients (Moore et al., 2020).

The aim of this doctoral project was to advance nursing practice by advocating for BCMA technology as the gold standard of modern medication administration in the ED, based on computer-assisted validation of the many “rights” of medication administration: right patient, right medicine, right dose, right route, right time, right patient education, right to refuse, and right documentation (Douglass et al., 2018). The BCMA application validates the medication administration process against EHRs by leveraging individually

barcoded unit-dose medications as well as patients' barcoded armbands (Macias et al., 2018). With the growing body of research indicating the significant effects of BCMA technology in reducing ADEs and improving patients' safety, there is a critical need to enable widespread use of such life-saving technology (Moore et al., 2020).

Local Background and Context

Despite an increasing body of nursing research supporting BCMA, less than 70% of American hospitals implemented the BCMA application across the entire continuum of care (Furakawa et al., 2017). EDs are often not included in BCMA rollouts based on historical fast-paced environment arguments or financial constraints (Owens et al., 2020). The practice problem of medication errors in the ED is significant, with many small community-based and large academic hospitals affected (Moore et al., 2020). While the project site, a 250-bed acute community-based hospital, is known for its commitment to quality care and innovation, the initial BCMA rollout did not include the ED. According to self-reported hospital PI data, the lack of a closed loop BCMA process in the ED caused much higher medication errors, thus presenting a significant local practice problem. Similar to observations by Moore et al. (2020), the decision to exclude the ED from the BCMA project was initially based on the operational concerns of "complicated and fast-paced workflow" as well as significant budgetary constraints. Not surprisingly, the existing practice problem with medication errors in the ED persisted. Since the initial implementation of BCMA, paper-based ED error rates have increased by an additional 3.8%.

The project site is a 250-bed acute care community hospital, recognized by the American Nurses Credentialing Center (ANCC) as a Magnet Hospital for nursing excellence. However, pre-COVID financial constraints affected the hospital's BCMA technology implementation strategy, resulting in the exclusion of the ED. The PI department plays a critical role in the project site's quality initiatives and data analysis. The PI nurses are responsible for various projects aimed toward improvements in patient safety. The data collected by the PI nurses indicated a significant safety concern, with 3.8% of medication administration error rates in the ED at the project site. The high rates of ADEs in the ED was identified as an organizational priority, especially given the reported reduction of medication errors post-BCMA implementation in medical-surgical and ICU departments.

Furthermore, The Joint Commission (TJC) released the much-anticipated 2021 National Patient Safety Goals (NPSGs) for the hospital program, which included medication administration (NPSG.03.04.01, NPSG.03.05.01, NPSG.03.06.01; TJC NSPG, 2021). Targeting improvements in the delivery of safe medication administration, the goals specifically target proper medication labeling, checking, and cross-referencing home versus current medications. TJC's focus on BCMA as the best practice for safe medication administration and error prevention has been well documented and continues to push organizations considering the HIT innovations as part of their care delivery (Moore at al., 2020).

Role of the DNP Student

As a longtime ICU nurse who transitioned to the informatics area of nursing practice, I believe in HIT as the catalyst for safer delivery of care. Over my many years of clinical practice, I have seen many medication errors made affecting the well-being of patients, which contributed significantly to my informatics journey in search of safer ways to enter and administer medications. Kuklik et al. (2019) emphasized the critical role that informatics nurses have in the quest for “zero harm.” Similarly, having worked on my DNP practicum at the project site, I was involved in providing evidence-based research data, supporting the use and QI evaluation of the BCMA in the ED, which was initially overlooked. Furthermore, I was fortunate to have the support of the project site chief nursing officer to be the change agent tasked with evaluating the BCMA workflow and its effects on ADEs. The primary motivation for the doctoral project is to provide additional QI data supporting the use of lifesaving BCMA technology in the busy, often unpredictable ED environment. The devastating effects of preventable medical errors in health care motivated my search for knowledge and alternative solutions to a paper-based process that is highly susceptible to error.

Pursuing my graduate and doctoral degrees at Walden University enabled me to grasp the steps required for enabling evidence-based research in daily clinical practice. It also opened additional perspectives on the lack of national and local standards related to BCMA. While there is a growing body of research supporting BCMA as a HIT innovation reducing medication errors and preventing patient harm, there has been little progress in making the new, BCMA-driven medication administration a standard of care

across the nation (Moore et al., 2020). As a bedside ICU nurse who transitioned to the nursing informatics area of practice, I recognized the potential for bias in the study based on my positive personal experience with using BCMA technology. However, the proper, rigorous study design and robust adherence to evidence-based research and QI principles served as a countermeasure to any unprejudiced considerations.

Summary

In this section, the persistent practice problem with errors in medication administration was reintroduced. Despite significant advances in information and nursing sciences, ADEs remain a substantial problem for acute care hospitals and account for an estimated 30% of all hospital adverse events, affecting almost 2 million hospital stays per year (Kuklik et al., 2019). It is hard to overestimate the relevance of safer medication administration to nursing practice. Similarly, leaders at the acute care hospital project site aimed to implement the BCMA but did not include the ED in the initial scope. This doctoral project leveraged Lewin's change theory as the framework for organizational change related to use and evaluation of BCMA technology in the ED.

Several recent studies have indicated that BCMA technology has significant potential for reducing ADEs by as much as 80% compared to paper-based medication administration in the ED while improving patient safety and nursing satisfaction (Hitti et al., 2018). My role as the DNP student in this project was to serve as a bridge between bedside nurses and IT professionals while advocating for the evidence-based BCMA technology to become the standard of care in the ED. In the following section, I discuss

the ADE data collection strategies as well as analysis of current literature supporting the use of BCMA in the ED.

Section 3: Collection and Analysis of Evidence

Introduction

The evidence-based practice project addressed the significant practice problem of errors during the medication administration process in the ED setting and the lack of QI data validating the efficacy of BCMA technology use in the ED. Unfortunately, ADEs remain a substantial problem for acute care hospitals and account for an estimated 30% of all hospital adverse events, affecting almost 2 million hospital stays per year (Kuklik et al., 2019). With the growing body of research describing the devastating quality and financial impacts of medication errors, there has been a bigger emphasis on the “do no harm” BCMA process and evaluation of outcomes (Strudwick et al., 2018). BCMA at the project site is defined as an electronic, real-time clinical decision support application aimed to establish and ensure many “rights” of medication administration: right patient, right medicine, right dose, right route, right time, right documentation, right patient education, and right to refuse (Van der Veen et al., 2020). The BCMA application validates the medication administration process against EHRs by leveraging individually barcoded unit-dose medications as well as patients’ barcoded armbands (Macias et al., 2018).

The purpose of this project was to evaluate successful strategies for translating new evidence into clinical practice by examining the efficacy of BCMA in the ED settings in reducing ADEs. A comprehensive analysis of the pre- and post-BCMA data for medication administration errors were leveraged as a quantitative tool for this project. In the following sections, the practice-focused question of BCMA efficacy in the ED will

be reintroduced, along with the evidence-based sources of evidence available, followed by the description of data storage, analysis, and synthesis.

Practice-Focused Question

The practice-focused question of this doctoral project was as follows: Will the implementation of BCMA in the ED effectively reduce medication administration errors as compared to the previously used paper-based, non-BCMA process? After the initial implementation of BCMA on medical-surgical and ICU units, the medication administration error rates in the ED consistently exceeded those of the rest of the organization. Moreover, the paper-based ED self-reported annual medication error rate of 3.8% was significantly higher than that of other nursing units.

The main purpose of the project was to evaluate the efficacy of BCMA in the ED as it relates to medication error rates. In the unpredictable and volatile postpandemic health care environment, the emphasis on prevention of harm to patients should serve as a “true north” for nurses around the country.

Sources of Evidence

Among the most important sources of evidence for this project, Furakawa et al. (2017) reported a substantial reduction in ADEs post-BCMA implementation in an acute care hospital. The researchers reported that the pre-BCMA ADE rate of 6.3% was reduced to 1.2% after implementing BCMA technology (Furakawa et al., 2017). These results represented a statistically significant ADE rate reduction of over 80%, leading authors to advocate for widespread nursing practice change to include BCMA. Furthermore, in a landmark study, Truitt et al. (2016) discovered that BCMA technology

decreased in-hospital medication errors by as much as 85%, reduced ADEs by 73%, improved documentation compliance, enhanced superior patient education, and led to decreased readmissions and enhanced patient safety.

The much-needed change in basic assumptions from the historically used paper-based medication administration toward real-time, electronic BCMA technology has significant implications for nursing practice (Owens et al., 2020). Unfortunately, ADEs remain a substantial problem for acute care hospitals and account for an estimated 30% of all hospital adverse events, affecting almost 2 million hospital stays per year (Kuklik et al., 2019). The far-reaching effects of ADEs on patients' mortality and morbidity are prompting acute care hospitals to reevaluate the entire medication administration workflow. Additional sources of data included in this project came from a PI department medication error reporting database with deidentified patient information.

The main goal of this project was to evaluate whether HIT such as the BCMA application could reduce medication errors as compared to the paper-based medication administration process. The current state of nursing practice in medication administration remains inconsistent, with many hospitals not leveraging lifesaving BCMA technology in the ED (Owens et al., 2020). Consequently, the data collection for this project was aimed at comparing the total number of medication errors before and after the BCMA intervention. To address the main practice-focused question of this project, a retrospective evaluation of the BCMA technology in the ED as a possible intervention to reduce medication errors was conducted. The rate of medication errors in the ED for 6 months before BCMA implementation (January–June 2019) was compared with the rate

6 months after BCMA implementation (July–December 2019) as well as the additional post-BCMA period of January to June 2022. Noticeably, this project’s data collection methodology and retrospective analysis were supported by multiple recent primary studies, which revealed that BCMA technology decreased medication errors by as much as 85%, reduced ADEs by 73%, improved documentation compliance, and led to enhanced patient safety (Strudwick et al., 2018). The retrospective collection and analysis of pre-and-post BCMA medication administration error rates provided the quantitative criteria addressing the practice-focused question of this project.

Archival and Operational Data

This DNP project enabled the quantitative evaluation of the BCMA-driven QI initiative in the ED by comparing data for nurse-reported ADEs 6 months before and 6 months after BCMA implementation. An additional comparison of ADE data was used for the January–June 2022 period retrospectively. The organization’s risk management and PI departments are leveraging commercial electronic, web-based incident-reporting software (e-IRS) for clinicians across the project site. Nurses are trained to use the e-IRS application as a self-reporting tool for a variety of incident reports, including quality metrics, delays in care delivery, and even inappropriate behavior by members of the medical staff. Nurses in the ED can complete confidential e-IRS reports from any computer workstation or hospital laptop and are encouraged to do so in a timely manner without fear of retribution. Access to data is protected by hospital security policies, and the data for the project were obtained via retrospective, deidentified reports from the PI team; no Protected Health Information (PHI) was included in the aggregated data

provided. The data collected by nurses were relevant to this project as they demonstrated a baseline preimplementation and postimplementation medication error rate. Moreover, the evaluation criteria for the project included the comparison of the pre-BCMA versus post-BCMA medication error rates in the ED. The anticipated limitations of the self-reported medication error data include human factors, considering that despite the nonpunitive, patient safety-driven culture, some medication errors might not be reported or properly identified. An additional limitation of this study might be an ongoing challenge with the ED nursing workforce's willingness and ability to override the BCMA process altogether, bypassing the safety net and best practices (Moore et al., 2020).

The self-reported medication error data were accessed via the deidentified monthly summary spreadsheets, containing no personal health information, based on the approval of the hospital PI department and the ED leadership team. For the purposes of this project, monthly summary reports reflecting the number of medication errors versus the total number of medications given in the ED were obtained with the permission of the PI department and the chief nursing officer.

Analysis and Synthesis

The DNP project focused on the quantitative evaluation of the BCMA-driven QI initiative in the ED by comparing the data for self-reported ADEs 6 months before and 6 months after BCMA implementation. Additional ADE data for possible retrospective analysis were used for the January–June 2022 period. Having supplementary data from 2022 provided another dimension in evaluating pre- and post-BCMA medication errors by minimizing the initial post-go-live resistance and lack of training variances. The

organization's risk management and PI departments leverage the commercial incident-reporting online software for clinicians across the project site. The retrospective ADE analysis of reports was conducted during the 6 months pre or post phases of the project and the January–June 2022 period. A comprehensive analysis of self-reported medication errors included wrong medication, wrong patient, wrong dose, or wrong route, as well as wrong time and omitted dose. Additionally, the error severity level was analyzed based on the self-reporting numerical classification levels (0–8), ranging from unknown (0), to harm that did not reach the patient (1–2), to permanent harm or death (8). The total number of monthly medication administration errors was calculated for the selected period pre- and post-BCMA implementation. The integrity of the collected data was preserved by the role-based, two step authentication process, eliminating unauthorized access to data as well as providing data audit capabilities.

Summary

In this section, the concepts of striving for a culture of “zero harm” during medication administration was discussed. The latest HIT innovations such as BCMA have been used to improve patient safety and reduce medication errors; hence, there was alignment between the selected sources of evidence for BCMA technology and the purpose of this doctoral project (Owens et al., 2020). It is hard to overestimate the relevance of safer medication administration to nursing practice. The main practice-focused question of this doctoral project was the following: Will the implementation of BCMA in the ED effectively reduce medication administration errors as compared to the previously used paper-based, non-BCMA process? While the project site, a 250-bed

acute community-based hospital, is known for its commitment to quality care and innovation, the initial BCMA rollout did not include the ED. The analysis of the primary research evidence supporting the safety-net role of the BCMA technology plays a critical role in making this evidence-based practice a standard of care in the ED (Bonkowski et al., 2013). The role as the DNP student in this project was to serve as a bridge between bedside nurses and IT professionals while advocating for the evidence-based BCMA technology to become the standard of care in the ED.

In the following section, I discuss the project findings, implications for nursing practice, and formal recommendations based on the retrospective data analysis.

Section 4: Findings and Recommendations

Introduction

In 2019, a not-for-profit acute 350-bed community hospital implemented BCMA technology to replace a paper-based medication administration process. The initial BCMA rollout included the medical-surgical and ICU departments; however, the ED was excluded from BCMA implementation. As in many other organizations in the country, the leadership of the hospital cited fiscal and ED workflow constraints in the decision to exclude the ED (Moore et al., 2020). However, the high rate of medication errors in the ED continued to present patient safety and associated financial concerns. Realizing the significant gap in practice, hospital leaders ultimately added the ED to the BCMA implementation project in July 2019. Moore et al. (2020) pointed out that EDs are often not included in the initial BCMA rollout in hospitals, which can lead to significant gaps in nursing practice and patient safety. The practice-focused question of this DNP project was the following: Will the implementation of BCMA in the ED effectively reduce medication administration errors as compared to the previously used paper-based, non-BCMA process? To evaluate the efficacy of the BCMA technology in the ED as a main goal of the project, I used pre- and post-BCMA data for retrospective analysis of this QI initiative, which were obtained from the PI department's database. Deidentified medication error data from a self-reported online incident reports database were obtained from January to June 2019 (pre-BCMA), July to December 2019 (post-BCMA), and January to June 2022 (post-BCMA). The aggregated data were analyzed using a one-sample t test. The findings and retrospective analysis for this project demonstrated a

significant reduction in medication errors post implementation by 68% ($p = .024$) during the initial 6 months and 63% ($p = .027$) 1-year post implementation, which indicates sustainability of the technology.

Findings and Implications

The purpose of the DNP project was to evaluate the efficacy of BCMA technology in the ED. The QI-based initiative at the acute, community-based hospital was aimed at reducing the rate of medication errors and ADEs as a result of implementing the BCMA application. The data were retrospectively evaluated for pre- versus post-BCMA implementation error rates. The analysis revealed a pre-BCMA medication error rate of 3.8% (Table 1) during the January–June 2019 period. During the post-BCMA evaluation period of July to December 2019, the retrospective data analysis indicated a medication error rate of 1.2%. Importantly, another comparative, retrospective review of post-BCMA medication administration data for January to June 2022 produced a 1.4% error rate. Those findings are in line with recent studies analyzing rates of medication errors. Kuklik et al. (2019) noted that medication errors in acute care hospitals vary from 2% to 7% of administered doses and present a significant practice problem along with a tremendous financial burden. Noticeably, this project's data collection methodology and retrospective analysis were supported by multiple recent primary studies, which revealed that BCMA technology decreased medication errors by as much as 85%, reduced ADEs by 73%, improved documentation compliance, and led to enhanced patient safety (Strudwick et al., 2018). The findings and retrospective analysis for this project demonstrated a significant reduction in medication errors post implementation by 68% ($p = .024$) during

the initial 6 months and 63% ($p = .027$) 1 year post implementation, which indicates sustainability of the technology. In addition, the application of classic change theory by Lewin, used as the framework for this project, enabled effective change management phases. Lewin's change theory was used as the organization aimed to implement the latest HIT application (BCMA) as a planned change. For any such planned change to occur, especially in the busy ED, the driving forces had to overcome the existing restraining forces, creating an imbalance. There was significant alignment between Lewin's change theory and this doctoral project based on substantial resistance to the BCMA technology in the ED. In addition, managing organizational change in the postpandemic health care environment requires an innovative if not formal framework in order to achieve sustained transformation of care delivery. Similarly, using Lewin's change theory, the project site leadership methodically applied unfreezing, change application, and refreezing stages for switching from a paper-based to BCMA-driven medication administration process. There are significant positive implications resulting from the project findings not only for individual patients, but also for the community that is served by the project site. Having the innovative HIT as a "safety net" that led to a decreased number of medication errors contributed to a positive social change while improving the quality of care in the ED.

Table 1*Rates of Reported Medication Errors in the Emergency Department*

Time frame	Total # of reported medication errors	Total # of medications administered	Percentage of medication errors
January–June 2019, pre-BCMA	2,561	67,410	3.8%
July–December 2019, post-BCMA	779	64,967	1.2%
January–June 2022, post-BCMA	957	68,394	1.4%

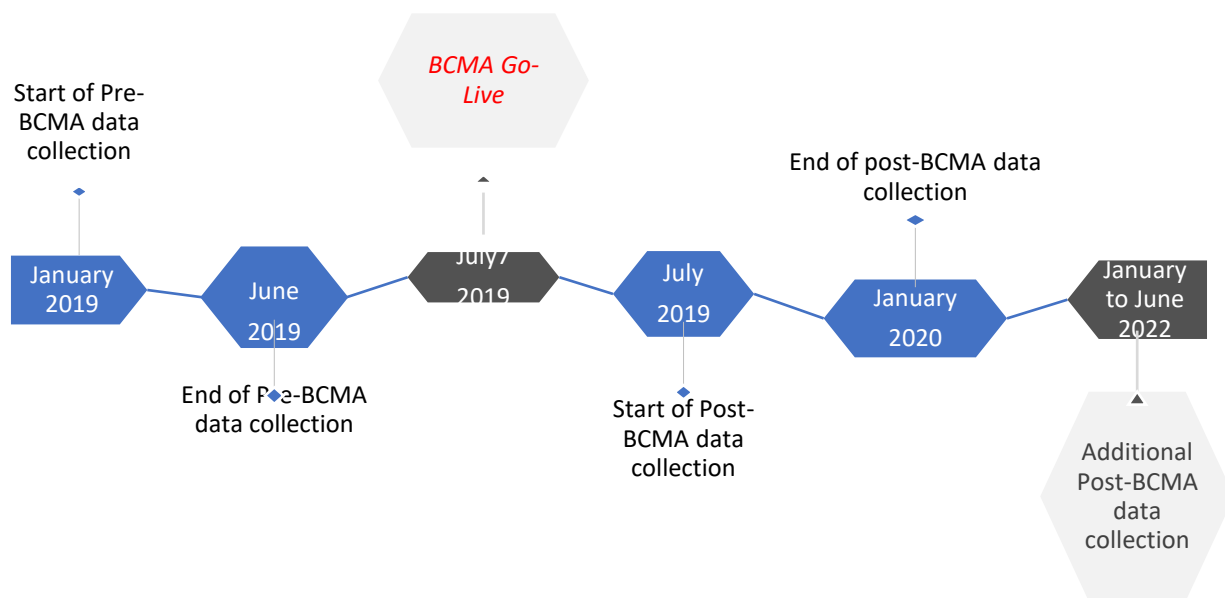
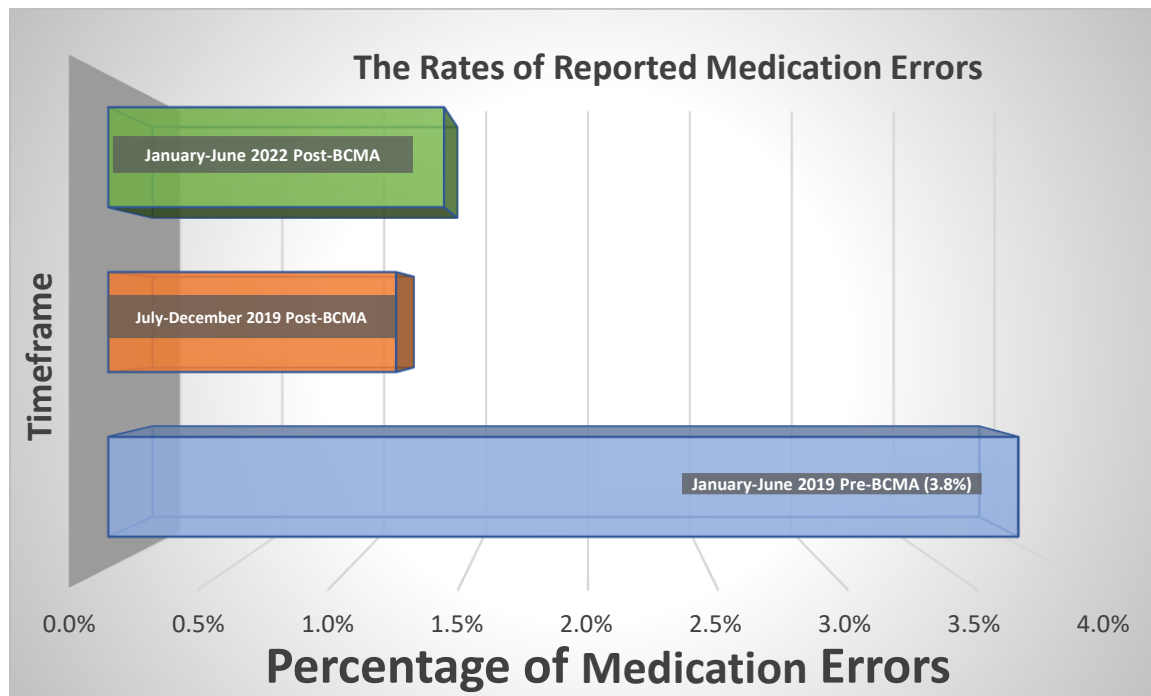
Figure 1*Timeline of Pre- and Post-Barcoded Medication Administration Retrospective Data**Analysis*

Figure 2

Rates of Reported Medication Errors in the Emergency Department



Recommendations

The main recommendation based on the project's findings is to change the current policy and mandate the use of BCMA in the ED as a standard of nursing practice.

Additionally, the implications of this DNP study aimed at evaluating the efficacy of BCMA technology in the ED support the notion of decreased medication error rates after the implementation of BCMA application. Despite the widespread administrative concerns of high cost and complex workflow in the ED, the retrospective analysis of medication errors post BCMA confirmed the immediate and long-term patient safety improvement as well as significant cost avoidance due to fewer ADEs. Data supporting the efficacy of BCMA should become practice guidelines and be leveraged by nurse

leaders to advocate for wider adoption of this life-saving technology across the continuum of care, including the ED.

Following the formal evaluation process for the efficacy of BCMA in the ED allowed me to apply Lewin's change theory to serve as the framework for HIT change affecting nursing workflow. I learned invaluable applied research methods and a scholar-practitioner approach all the way from the literature review and executive presentations during the unfreezing phase of a nursing practice change, to the implementation of BCMA in the ED during the change phase, and into evaluating the efficacy of BCMA by analyzing medication administration error rates during the refreezing stage.

Strengths and Limitations of the Project

A strength of the project is the evaluation criteria for the efficacy of BCMA in the ED. Having the medication error rate as the target for the main hypothesis, it enabled a clear and quantifiable approach to the retrospective data analysis. In addition, the organization's willingness to share the information and optimize the BCMA process led by the CNO was a major strength. Having a robust, evidence-based project framework based on Lewin's classic change theory was extremely valuable, as the organization struggled with the initial change management process for BCMA.

Several limitations of the project should be noted. While the nonpunitive organizational culture encouraged nurses to self-report medication errors, it is possible that the total numbers of medication errors might still be underreported. Further, the fast-paced, unpredictable ED environment often leads to nurses overriding safety nets during medication removal and administration (Moore et al., 2020). Another important

limitation of this project was the participation of only one organization in a single metropolitan geographic area of the United States; hence, the findings might not be generalizable.

Future projects addressing the efficacy of BCMA might provide additional insights while leveraging similar retrospective analysis and involving more than one organization in various geographic settings. Expanding the quantitative methods to include medication administration override rates and the financial impact of ADEs on length of stay during hospitalization might broaden the research applicability for acute care hospitals.

As a Walden University DNP student, I strived to become a scholar-practitioner, change agent, and advocate for better patient outcomes through the use of HIT innovations. Reflecting on the DNP Essentials and the practical application of nursing research, I aimed for positive social change by eliminating medication errors in the ED and improving the safety of the patient population that we serve.

Section 5: Dissemination Plan

The dissemination of evidence-based research findings and incorporation of recommendations into everyday practice remains a significant challenge for the nursing workforce (Mick, 2019). Consequently, the plan for dissemination of this DNP project includes completion of the project plan and executive summary for the project site's bedside nurses as well as nursing leaders.

Publishing the results of the BCMA evaluation in the ED settings would also provide a wider audience with primary research data supporting the change in practice. As a member of the American Nursing Informatics Association as well as the Florida Nursing Association, I plan to submit presentations to both organizations' annual conferences and technology user groups. Additionally, working with local and state political leaders, I will launch the BCMA advocacy campaign to target legislative changes aimed at improved patient safety standards.

Analysis of Self

As a seasoned ICU nurse who transitioned to the informatics area of practice, I found that this DNP project presented a unique opportunity to address clinically driven, technology-related change management strategies. Striving to be a change agent advocating for the adoption of evidence-based HIT such as BCMA allowed me to enhance my professional skills as a scholar-practitioner. The opportunity to work on the practice-based BCMA evaluation project also enabled me to connect the theoretical knowledge gained during my time at Walden with applied research principles used to evaluate this QI initiative. Collaboration with multiple medication administration

stakeholders such as frontline ED nurses, pharmacists, and nursing and PI leaders helped me to solidify knowledge of the workflow and possible workarounds existing in the ED environment (Terry, 2015).

Among the greatest challenges that I encountered during this project, the COVID-19 pandemic clearly stands apart. Having to operate during an unprecedented health care crisis, the project site and the entire nursing workforce were under prolonged duress and deserve immense recognition and gratitude for their efforts in the implementation and sustainment of this project. Not surprisingly, shifted operational priorities extended the project timeline and resource availability.

Reflecting on the project experience, I realize that the continuous encouragement, motivation, and thoughtful guidance provided by my committee chair served as my lifeline during times of self-doubt and frustration. I am also extremely grateful for the opportunity to learn the much-needed theoretical change-management framework based on Lewin's theory. It is critical for nurses to combine formal research principles with practical application of evidence-based knowledge (Mick, 2019). In addition, having the long-term professional goal of advocating for technology as a catalyst for nursing workflow changes and improved patient safety, the DNP project experience could serve as a blueprint for future evidence-based projects.

Summary

The focus of this DNP project was to address the practice gap in safe medication administration in the ED. Evaluation of BCMA application and its effects on medication administration error rates in acute care was conducted via retrospective data analysis.

Lewin's classical change theory served as the theoretical framework for the project. The evaluation of the organizational change management effectiveness and empirical evaluation of ADE rates pre- and post-BCMA were completed. This DNP study aimed at evaluating the efficacy of BCMA technology in the ED supported the notion of decreased medication error rates after the implementation of BCMA application. The findings and retrospective analysis for this project demonstrated a significant reduction in medication errors post implementation by 68% ($p = .024$) during the initial 6 months and 63% ($p = .027$) 1 year post implementation, which indicates sustainability of the technology.

While the project did have its limitations due to the nature of nursing self-reported medication administration errors, a singular site, and possible workarounds during medication removal and overrides, it demonstrated the efficacy of the BCMA application in the ED due to a statistically significant decrease in ADEs versus the pre-BCMA manual paper-based documentation process.

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