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Nursing Approaches for Use and Sustainability of Barcode Medication Administration Technology

Jackson Ngigi Njeru
Walden University

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Walden University

College of Health Sciences

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Jackson Njeru

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Walden University
2017

Abstract

Nursing Approaches for Use and Sustainability of Barcode Medication Administration

Technology

by

Jackson Ngigi Njeru

MSN, University of Mary, 2012

BSN, Missouri Western State, 2009

BSc, Kenyatta University, 1999

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Nursing

Walden University

November 2017

Abstract

Approximately 43.4% of medication errors occur at the time of administration despite the use of bar code medication administration (BCMA) System. This trend has prompted a national effort to mitigate this problem in the United States. Implementing BCMA in health care settings is one of those efforts. Studies focusing on the approaches employed by nurses when using this system are scant. The purpose of this qualitative case study was to investigate strategies nurses and their leaders use to ensure BCMA is implemented, maximized, and sustained. The technology acceptance model was used to guide the study. The 2 research questions addressed nurses' perceptions regarding the use and optimization of BCMA, and approaches of clinical nurses and their leaders to ensure that BCMA technology is properly used, optimized, and sustained in acute care units. Data collection included semistructured interviews with 8 participants. Thematic data analysis generated themes including ease of use, reduce errors, time saving, old technology, overreliance on technology, paper backups, and hope for future development. Common barriers to system effectiveness were system errors and inadequate training; intragroup and self-monitoring were important strategies to sustain use of the system. Study results may be used by health care leadership to reduce medication errors by adopting easy to use technology, change policies regarding training of BCMA end users in hospitals, increase the culture of patient safety among nurses, and prompt technology redesign within health care setting that meets the national patient safety goals.

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Dedication

I never knew that such a small gesture could mean so much in one's life. Mum, when growing up, you made a simple prayer every morning. You gave me a loaf of bread as a gift when I topped the class at the end of the academic session. That simple act energized me. This is for you, Mum.

Acknowledgments

I must express my gratitude to my committee members, Dr. Donna Bailey (chair), Dr. Corinne Wheeler (committee member), and Dr. Edna Hull (university research reviewer), who patiently provided me with personal and professional guidance throughout this project.

I would like to thank and acknowledge the medical center in greater Dallas metropolis (name masked) for making this project possible by providing the site for my study. Thanks are also due to all the research site staff led by Director of Clinical Education and Professional Practice who assisted and coordinated all administrative process and resources. I acknowledge the contribution of all the nurses who agreed to participate in this project in the midst of their busy schedule.

It would have been very difficult to complete this work without the support, prayers, and patience of my family members. I cannot forget PhD nursing students such Tammy Schossler at Walden University, who provided a much needed form of escape from my studies and helped me keep things in perspective.

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Chapter 1: Introduction to the Study

The safety of the patient is a global issue and is not a single hospital's problem (Aiken et al., 2012). According to Bonkowski (2013) and Van Den Bos et al. (2011), the purpose of health care information technologies is to prevent errors in hospitals that could easily harm patients. It is not uncommon to see unnecessary deaths occurring due to medical harm year after year (Tzeng, Yin, & Schneider, 2013). In the United States, the number of patient deaths per year due to preventable errors in hospitals was up to 98,000 by the year 2000 (Kohn, Corrigan, & Donaldson, 2000). A relatively recent study indicated this number to be four times higher (James, 2013). These statistics prompted organizations and government agencies such as the Agency for Healthcare Research and Quality (AHRQ) to provide financial support for research involving patient safety (Wang et al., 2014). However, this problem is far from resolved, according to a report released by National Patient Safety Foundation in 2015 (Gandhi, Berwick, & Shojania, 2016). Health care safety experts and stakeholders have developed stringent measures and recommendations to improve the situation. These recommendations included supporting the clinical staff and guaranteeing that any technological system applied by these staff is both safe and fully optimized with the goal of improving patient safety (Gandhi et al., 2016). Some programs implementing these recommendations have shown reduced numbers of deaths associated with medical errors such as hospital infections (Pronovost, Cleeman, Wright, & Srinivasan, 2016).

Due to many cases of medication errors reported in the United States, there has been a national effort to address this problem (Pronovost et al., 2016; Wang et al., 2014). One of the approaches includes the use of health technology systems like barcode

medication administration (BCMA). Aiken et al. (2012) described BCMA as a significant health care technology that has not only increased patient safety and operational efficiency, but has also ensured confidentiality and lowered expenses associated with care delivery. In the United States, about 65.5% of registered hospitals had employed BCMA by the year 2012 (Pedersen, Schneider, & Scheckelhoff, 2012). According to Weston and Roberts (2013), many BCMA technologies implemented in health care centers have been shown to reduce the number of medication errors by almost 80%. This suggests that BCMA is an important health care technology that cannot be ignored, and its benefits need to be optimized and sustained. A recent analysis of occurrence reports indicated that 43.4% of medication errors occur at the time of administration despite the use of BCMA (Yang & Grissinger, 2013). This finding indicated that some problem is leading to suboptimization of BCMA technology and undermining its success and sustainability (Koppel, Wetterneck, Telles, & Karsh, 2008). Therefore, there was a need to understand nurses' approaches in using BCMA technology. The National Academy of Medicine (NAM) encouraged hospitals to safeguard the technologies' safety and find ways to optimize their use (Gandhi et al., 2016).

Background of the Study

Nurses are usually the primary end users of most health information technology (HIT) systems such as electronic medical record and BCMA. Nurses require continuous support not only to implement HIT systems (Novak, Anders, Gadd, & Lorenzi, 2012) but also to improve safety and prevent unintended patient harm (Moss & Berner, 2015). Recent exploratory studies revealed that nurses' support of HIT use has focused more on

adoption, technical assistance, and usability (Zahabi, Kaber, & Swangnetr, 2015).

However, there are no adequate or straightforward approaches adopted by clinical nursing staff and their leaders to ensure proper use and sustainability of HIT such as BCMA (Shachak et al., 2013; Zahabi et al., 2015). Some researchers have recommended more emphasis on understanding nurses' preferences, needs, concerns, and expectations regarding HIT (Taliercio et al., 2014). Most researchers have emphasized not only the safety outcomes of BCMA technology but have also advocated for continued implementation to avert suboptimization and to increase sustainability of HIT (Van de Glind, Heinen, Evers, Wensing, & Van Achterberg, 2012). Support for the end user is a multifaceted issue that may vary significantly depending on clinical workflow, use of a given HIT system, and related influences (Moss & Berner, 2015). Nurses and their leaders need to understand and define their best approaches for using any HIT (Shachak et al., 2013). This understanding is essential if nurses want to reap the maximum benefits of BCMA and sustain its use.

Problem Statement

Some researchers have examined ways that clinicians use technological systems such as BCMA to maximize their benefits (Savage, Titus, Manns, & Lee, 2014; Stagers, Iribarren, Guo, & Weir, 2015). However, researchers have not examined action plans or approaches by nurses and their leaders to sustain BCMA technology and maximize its use. This gap in the literature prompted the current study. The general problem was that researchers had not looked at the action plans put forward by hospital leadership for implementing and sustaining BCMA technology. The specific problem was that clinical

nurses and nursing leadership, in collaboration with hospital leadership, lacked strategies to ensure maximum use of BCMA technology or plans to sustain this technology in acute care units. Maximum use of BCMA technology may not only positively impact health care operations and patient outcomes but may also influence the formulation of policies on future technologies, training, communities, and shareholders. The problem was lack of understanding of how nursing staff and leaders sustain the use of BCMA to maximize its value in quality patient care and safety.

Purpose of the Study

The purpose of this study was to understand the approaches that nurses and their leaders have used to ensure proper implementation of BCMA technology and its sustainability in acute clinical care units. To satisfy this purpose, I used a qualitative case study design. Other researchers used a case study design to explore safety outcomes of BCMA technology and advocate for its continued implementation to prevent suboptimization and increase sustainability (Van de Glind et al., 2012). A case study approach is a form of real and practical inquiry that allows a systematic and rigorous examination of real-life situations (Cronin, 2014; Verner & Abdullah, 2012). Data collection included memos, policies, and interviews to advance the understanding of the current approaches and plans created by nurses and their leaders to use and sustain BCMA.

Research Questions

This case study was conducted to answer two questions: (a) What are nurses' perceptions of the use and optimization of BCMA and patient outcomes? (b) What

approaches do clinical nurses and nursing leadership have in place to ensure that BCMA technology is appropriately used and sustained in the acute care units?

Conceptual Framework

I used the technology acceptance model (TAM) developed by Davis (1989). The TAM has been used to predict implementation and continued intentional use of different technological applications in diverse settings (Rauniar, Rawski, Yang, & Johnson, 2014). This model is regarded as an explanatory conceptual framework (Rauniar et al., 2014) that has received acknowledgments, validation, and justification of use (Pai & Huang, 2011). These acknowledgments are due to its application in human behavior and advancement, implementation and sustaining of HIT (Cheung & Vogel, 2013; Rauniar et al., 2014). Further, TAM's key concepts have been shown to have powerful impacts on the intention of IT users in health care settings (Lin, Fofanah, & Liang, 2011). Research findings indicated that the key constructs in TAM could be used to predict the success or failure of a given IT project at any given setting (Holden & Karsh, 2010). The TAM conceptual framework provided a lens for me to examine approaches that nurses and their leaders use to implement and sustain BCMA in the chosen health care setting. TAM was an appropriate framework to use for this study because it is a frequently used framework, and the concepts of perceived usefulness, perceived ease of use, attitude toward use, behavioral intentions to use, and actual use aligned with the problem of continued optimal use and sustainability. A thorough explanation of the TAM and how it relates to methodology, interview guide development, data analysis, limitation, strength, and research questions is presented in Chapter 2.

Nature of the Study

I used a qualitative case study design including semistructured interviews to collect data from nurse leaders and nurses who are the end users of BCMA technology. A case study involves an intensive study of a group, individual, or situation (Sangster-Gromley, 2013). The emphasis on how individuals perceive, believe, perform, or behave is more practical and accurate when such individuals share their experiences in a case study (Baxter & Jack, 2008). Simon et al. (2013) provided a rationale for the use of a qualitative research approach in the evaluation of HIT systems. Further, Simon et al. gave a justification for investigative studies especially when it comes to health technology systems that are relatively new compared to technology systems applied in other disciplines such as education and business. Van de Glind et al. (2012) used the case study approach to examine implementation of a nursing intervention and described the strength of using a case study. Baker (2011) and Van de Glind et al. (2012) emphasized the need for additional case studies for hospital-related program implementation. A case study is a real and practical inquiry that permits a systematic and rigorous examination of real-life circumstances (Cronin, 2014; Verner & Abdullah, 2012).

Definitions of Key Terms and Concepts

Bar code medication administration (BCMA): A health care technology system that includes barcodes to avoid common errors during prescription and administration of medications at health care centers (Lee, Lee, Kwon, & Yi, 2015). The primary objectives of this technological application are to control the medication inventory and to confirm and simultaneously document the medication administration (Lee et al., 2015). BCMA is

used to make sure that the correct medication and dose are given to the right patient at the right time. A barcode system intended to avoid medication errors in a health care environment improves the quality and safety of medication administration (Savage et al., 2014). This system improves accuracy, prevent errors, and generates online records of medication administration in real time (Staggers et al., 2015).

The system comprises a portable barcode reader, laptop or desktop computer with either wired or wireless connection, and a computer server installed with appropriate software (Miller, Fortier, & Garrison, 2011). Both the physicians' ordering system and pharmacy transcription system are linked to the BCMA system. When the patient is receiving medication, the nurse scans the barcode on the band placed on the patient's wrist. The user then scans the appropriate barcode on medicine. The nurse confirms with a barcode reader that the medication, dose, time, and route are correct (Miller et al., 2011).

Medication error: An inappropriate medication administration that might lead to patient harm. These occurrences are considered medication errors if the health care professional is handling the medication to administer to the patient (Kelly, Harrington, Matos, Turner, & Johnson, 2016).

Suboptimization: Mistakes or anomalies due to policies in a given establishment (de Souza & Pidd, 2011). Suboptimization could result from a practice in which the organizational culture focuses on one component or area while overlooking the effects of other components (Peltokorpi, Linna, Malmström, Torkki, & Lillrank, 2016). For example, in health care, an organization that has initiated a BCMA system may focus

more on reducing the cost of operation than enhancing the efficiency of the system and reducing medication errors.

Assumptions

Researchers conducting case studies are concerned with how individuals or groups see their experiences and lives and give meaning to their world (Kouchaki, Okhuysen, Waller, & Tajeddin, 2012). I assumed that semistructured interviews would reveal strategies that nurses and their leaders use to maximize BCMA and sustain the benefit of this technology. I also assumed nurses would provide honest, accurate answers when describing the current situation of technology use in their clinical environment as end users. The participants were nurses employed by the same hospital but who worked in different medical units in the hospital. I assumed that participants had similar or related experiences using the BCMA system. In addition, I assumed that participants were experts in the subject matter under investigation. This assumption can be a source of method bias if the assumed experts do not provide accurate answers for whatever reason (Podsakoff, MacKenzie, & Podsakoff, 2012).

I was the principal tool for data collection and analysis. I expanded, clarified, summarized, and explored the data as needed to provide a description of the process and understanding obtained through interview responses (see Kirkwood & Price, 2013). I assumed that the results from this case study would be similar to related clinical environments using a comparable technological system. I had experience working with BCMA technology. However, I assumed that my experience would not be a source of bias during data collection and analysis.

Scope and Delimitations

Delimitations included the population from which the sample was taken, the setting, the framework, and the data collection tool. These factors and conditions might have affected the study methods and analysis of research data. The first delimitation was exclusion of literature on health care technology older than 12 years. This decision was made because the technology has changed dramatically over the last decade. The second delimitation was data collection was carried out from only one hospital. If data from two or more hospitals were to be collected, each hospital would have required a separate IRB authorization process. This process would have been time-consuming and would have extended the time frame of this study. The study was also limited to the use of the TAM conceptual framework. Other related theories and conceptual frameworks such as social construction of technology (Kuziemsky & Kushniruk, 2014), TAM2, and the unified theory of acceptance and use of technology (UTAUT) (Samaradiwakara & Gunawardena, 2014) were considered but were not selected. This study was not designed to observe nurses while administering medication in their respective patient care areas. Instead, the interviews were conducted in other locations convenient to the participants such as the break room, office, and cafeteria. My decision not to include observation as a method of data collection could have confined my ability to explore additional nursing approaches to increase triangulation. Future case studies may benefit from additional data collection techniques such as observation of nurses when performing their duties to increase triangulation. However, participants' facial expressions, body language, and tone of voice were noted and recorded during face-to-face interview sessions.

Limitations

Studies in this area of health technology are scant (Zahabi et al., 2015). The TAM was used as a framework because it had a well-established history in evaluating HIT systems. However, critics pointed out that the TAM has questionable exploratory or investigative significance and that it has limited predictive ability (Bagozzi, Davis, & Warshaw, 1992). There were limited choices as far as conceptual or theoretical frameworks in the area of health care technology because this area is in its infancy, and the TAM was the best fit for my study. Acknowledging the limitations, assumptions, and biases affecting the study results can increase credibility or transferability of the findings to a different setting (Malterud, 2001).

Another limitation of this study was generalizability of outcomes. A case study, like most qualitative studies, is small in scale, and questions regarding validity and reliability usually arise when it comes to the integrity and credibility of results (Anderson, 2010). My study involved a small sample in a specific geographical area, which limited the generalizability of the results. Other researchers using the semistructured interview questions designed for this study might discover different perspectives when using a different sample.

It can be challenging to demonstrate rigor in qualitative research unlike in quantitative research (Morrow, 2005). However, following the necessary steps can enhance credibility (Noble & Smith, 2015). Credibility could be established by conducting member checking in which researchers allow respondents to review transcripts, analyze findings, and report feedback regarding the researcher's interpretation

of data (Anderson, 2010). Morse (2015a) recommended interviews with experts in the subject matter especially when open-ended questions are used to reach data saturation.

Significance of the Study

The implications of the study included filling a gap in the literature, applying the findings locally, and influencing related communities and organizations.

Implications for Nursing Literature

This inquiry added to the body of literature about HIT optimization after the main implementation. The insights gained from this study may help researchers formulate more precise research questions or develop a hypothesis from topics such as the effects of suboptimization of a BCMA system in an acute care setting on patients' outcomes. Understanding gained from this study may help hospital leaders and project managers apply workable strategies to implement and sustain medication administration technology. Additionally, the study may provide evidence of service use, usefulness, and demand to justify the need for further funding and support by different agencies. This study may also prompt institutional management to include or redesign ongoing education for staff in the use of the technology as well as quality management follow-up for optimal use.

Implication for Practice

Findings from this study may not only add to the body of nursing knowledge about HIT but also function as a tool for evaluation of effective utilization of BCMA. Another implication of this study involves the economics behind the BCMA. Findings may be used to call for changes in policies regarding business partners, future

technology, employee training, and shareholders (see Jones, Rudin, Perry, & Shekelle, 2014). Medication errors can result from staff nurses not using BCMA technology appropriately due to sustained nursing workarounds (Debono et al., 2013). For this reason, optimization of BCMA technology and sustaining its use by nurses may decrease medication errors, increase patient satisfaction, and promote a culture of safety. The insights gained from this study may also encourage hospital leaders and HIT project managers to apply only those strategies that could foster the success of BCMA technology use and its sustainability. The feedback from nurses as the end users in the BCMA could also bring about technology redesign and improvement making it more efficiently aligned with the work that nurses do. Concerning patient outcomes, McCullough, Parente, and Town (2016) agreed that any HIT that is meant to improve efficiency, accountability, and safety could result in a positive patient outcome. Some of the notable outcomes may include improved cross-specialty care, lower cost of care, and reduced death rate.

Significance for Positive Social Change

Understanding the use and sustainability of BCMA promotes social change by reducing medication errors and the overall cost of medical expenses among community members in health care centers. Reduction in errors may translate into a reduction in morbidity and mortality related to those medication errors. Members of the community may receive health care services in health care centers using this technology. Health centers that have not adopted the BCMA technology may start considering the possibilities of implementing it. Medication errors are expensive for any health care

center (Samp, Touchette, Marinac, & Kuo, 2014). If health care centers have a good understanding of the short- and long-term effects of these errors, they will be able to justify why BCMA technology is necessary for reducing cost, risk, and inefficiency associated with these mistakes.

Summary and Transition

This chapter included the problem statement, purpose of the study, research questions, and conceptual framework. I also discussed the nature of the study, definitions of key terms, assumptions, limitations, delimitations, and the significance of the study. The purpose of this study was to explore nurses' perceptions of the use and optimization of a BCMA system and patient outcomes, and the approaches clinical nurses and nursing leadership had in place to ensure that the implemented BCMA technology was properly used and sustained. To satisfy this purpose, I used a qualitative case study design guided by the TAM). I used a purposeful sampling method and open-ended semistructured interview questions to collect data and identify themes. The study may fill a gap in the literature, enlighten hospital leaders and project managers on workable strategies, and provide evidence of service use, usefulness, and the need for further funding and support by different agencies. The study may trigger changes in policies regarding business partners, future technology, employee training, and shareholders. In addition, findings may be beneficial in justifying continued BCMA technology use in reducing cost, risk, inefficiency, and medication errors. The next chapter presents a review of the literature related to the study topic.

Chapter 2: Literature Review

A literature review involves evaluation of books, peer-reviewed articles, and other sources pertinent to a specific area of research, by providing a detailed account, concise summary, and critical evaluation of all work related to the study problem. A good literature review could form the basis for knowledge advancement developing a theory or a model (Rudestam & Newton, 2014). A strong literature review reveals what is already done and what future inquiries need to focus on (Webster & Watson, 2002). This literature review includes the following sections: literature search criteria, role of conceptual frameworks, TAM, trends in HIT, and medication errors and patient safety. Other sections include BCMA, nurses as end users, and nature of the study. Selection of literature was done according to relevance to the research topic and the date the material was published.

Literature Search Criteria

The literature review on BCMA included background searches of electronic medical records (EMR), the emergence and growth of barcode technology systems, and the benefits and challenges facing this technology. Additionally, I gathered information about medication errors and BCMA adoption, implementation, and success. Finally, I incorporated information pertinent to professional works associated with the conceptual framework for this study, current research, and existing gaps in the literature. The principal databases used to gather the relevant information included CINAHL Plus with Full Text, ABI/INFORM, MEDLINE, Health and Medical Complete, Health Sciences, EBSCOhost, SAGE Publications, Ltd, and SAGE Full-Text Collection. I also used

Nursing, Scopus, Google Scholar, ProQuest, and University of Texas library databases. Materials from these databases included peer-reviewed articles and journals, official government reports, and materials from Internet sources. I placed a limit on studies conducted within the past 15 years because nursing technology application in health care is a relatively new phenomenon and no adequate studies had been done in this area (Bates & Gawande, 2003). To identify appropriate materials, I used a combination of search terms such as *medication errors*, *electronic medical record*, *barcode medication administration*, *technology adaptation model*, and *health information technology*.

Conceptual Framework

Role of Theory and Conceptual Framework

Most experts have neither established a joint stand on an exact role of theory or a conceptual framework in qualitative research nor disputed the significant role both play in qualitative approaches (Tavallaei & Abu Talib, 2010). However, to realize knowledge development, most qualitative researchers emphasize that the study and theoretical or conceptual framework's interpretation will typically exist concurrently (Mitchell & Cody, 1993; Sandelowski, 1993). Theories or frameworks provide a set of concepts for defining and explaining phenomena, thereby allowing the researcher to shift from a simple to comprehensive description, analysis, and clarification (Malterud, 2001; Silverman, 2001). It is possible to threaten neutrality when researchers fail to recognize the effect of the framework in the study because concepts and models for data interpretation are derived from a specific theoretical foundation (Malterud, 2001). Several ways that a theory can influence a given study are recognized (Kelly, 2010). They include but are not limited to

the choice of research design, the research question, methodology, analysis, and overall quality of research (Kelly, 2010). In the same manner, the theory can be used to suggest various ways to explain the causes or effects (Reeves, Albert, Kuper & Hodges, 2008). Further, the theory can provide researchers with different viewpoints when looking for ways to solve problems (Reeves et al., 2008). These viewpoints enable researchers to have a lens through which data collection and analysis can be examined (Reeves et al., 2008).

Conceptual Framework

Several technological models and theories have been used to explain utilization and acceptance of different technologies in different settings (Samaradiwakara & Gunawardena, 2014). I used the TAM as a conceptual framework. Like the TAM, most technology models and theories such as cognitive dissonance theory, task-technology fit model, clinical adoption framework, and model of PC utilization were developed before 2000 (Samaradiwakara & Gunawardena, 2014). Newer models like TAM2 and UTAUT were designed after 2000 and had added extra dimensions to the older models (Samaradiwakara & Gunawardena, 2014). The UTAUT model, for example, added age, experience, gender, and social influence as moderators that affect the use and acceptance of a technological system (Venkatesh, Morris, Davis, & Davis, 2003). These models differ in factors such as origin, limitations, and implementations (Khan & Woosley, 2011). Not one model is superior for exploring how technology is accepted. The absence of a commonly used model made TAM, which was older than UTAUT, appropriate for this study.

The TAM has been used to predict the implementation and continued intentional use of different technological applications in diverse settings (Rauniar et al., 2014). This model is regarded as an explanatory conceptual framework (Rauniar et al., 2014) that has progressively received acknowledgments, validation, and justification of use (Pai & Huang, 2011). These acknowledgments are due to its application concerning human behavior in advancement, implementation, and sustaining of HIT (Cheung & Vogel, 2013; Rauniar et al., 2014). Further, TAM concepts have been shown to have potent impacts regarding the intention of IT users in health care settings (Lin et al., 2011). The key constructs in TAM could be used to predict the success or failure of a given IT project in any given setting (Holden & Karsh, 2010). The TAM conceptual framework provided a lens through which this study was conducted. Because this is a frequently used framework and the concepts of perceived usefulness, perceived ease of use, attitude toward use, behavioral intentions to use, and actual use aligned with the problem of continued optimal utilization and sustainability, the TAM was appropriate for this case study.

Justification and Aligning With Methodology

I sought to identify approaches that nurses and their leaders have applied in the process of implementing BCMA technology to maximize its potential and sustain its usefulness. This study was both an investigative and evaluative qualitative project involving a case study design. Many HIT experts agree that the primary concern for hospital and health care policymakers regarding technology implementation is acceptance of technology by end users (Abdekhoda, Ahmadi, Dehnad, & Hosseini, 2014). Although

there are many information systems, conceptual frameworks, and theories, this study was served well by TAM as a conceptual framework as it seemed to be a suitable model for understanding conceptual issues. The following definitions and explanations of TAM's key concepts provide further justification for the model's use in this study.

Perceived usefulness. After a project or technology is implemented in a health care setting, individual users develop intent to either use or not use the technology according to the belief that such technology will support their job performance (Khan & Woosley, 2011). The TAM labels this construct *perceived usefulness* (PU) (Davis, 1989). This construct implies that if technology improves a person's performance of a task without a significant increase in energy needed to do that task, then it is considered to have a beneficial effect (Davis, 1989). An individual user will be more likely to embrace a technology or related behavior with a subsequent decrease in suboptimization of that technology (Wallace & Sheetz, 2014). The user will also be more likely to adopt upgrades and attend continuing education offered by the institution for that technological system. Figure 1 shows pertinent constructs of TAM used in the study.

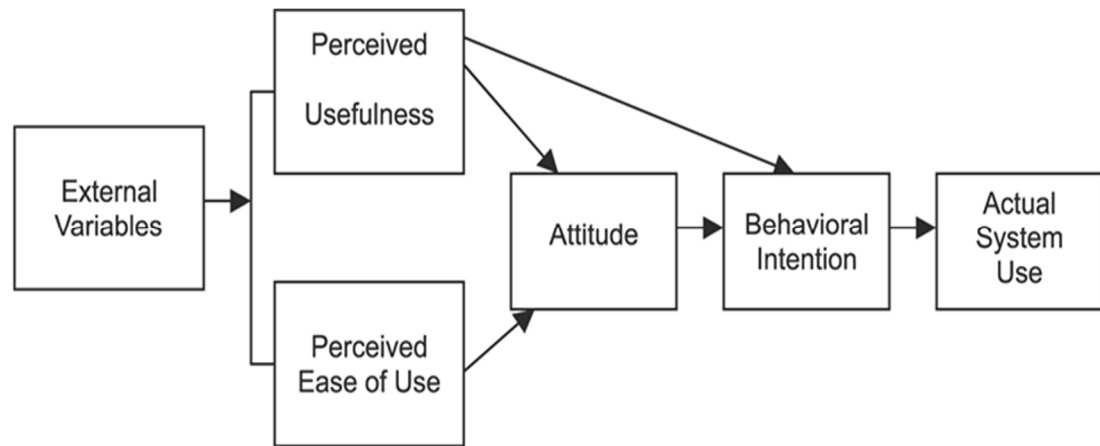


Figure 1. The final version of technology acceptance model (Venkatesh & Davis, 1996). Copyright 1996 by Davis. Permission to reproduce granted by the owner. Formal permission to reproduce the technology acceptance model for academic work not required. (Appendix D).

Perceived ease of use. End users may form an opinion that a particular technological system is beneficial. At the same time, these individuals may have a notion that it may be too difficult to learn that technology, diminishing the beneficial effects. Davis (1989) called this *perceived ease of use* (PEOU). A technological system perceived to be useful and easy is more likely to be accepted and adopted (Khan & Woosley, 2011).

Behavioral intentions to use. According to the TAM, perceived ease of use and usefulness determine the end users' attitude, which in turn dictates the behavior (Lin et al., 2011). Behavioral intention to use could result in technology use or lack of use (Davis, 1996; Tsai, 2014; Wallace & Sheetz, 2014). For example, system issues such as short staffing might interfere with technological systems not because the system is not seen as useful or easy to use but because of the pressure mounted by external factors. Various studies have indicated that key constructs from TAM can predict IT systems success in many settings, thereby justifying use of the TAM (Abdekhoda et al., 2014;

Peek et al., 2014). The concepts of PU and PEOU influence the intentions of the individuals to use a given technology (Tsai, 2014; Wallace & Sheetz, 2014).

External variables. The PU and PEOU could indirectly be affected by a cluster of external variables (Venkatesh & Davis, 1996). In this study, such aspects were outside of the clinical areas where BCMA is implemented. These factors include contextual variables, system design features, and organizational management (Camisón & Villar-López, 2014; Kimberly & Evanisko, 1981). The PU and PEOU concepts could interact with each other or independently to impact the behavioral intent to use the technology.

The TAM is robust and reliable when predicting and explaining technological acceptance behavior in many settings (Gagnon et al., 2014; Tsai, 2014). I used it to identify practices that the nurses follow to carry out their duties using the BCMA system. I also explored nurses' attitude about BCMA usefulness and ease of use to determine the sustainability of this health technology system. The assessments of different technological theories and models indicated that the TAM is easier to apply in various research and practice settings including health care (Samaradiwakara & Gunawardena, 2014). Additionally, Samaradiwakara and Gunawardena (2014) asserted that TAM provides an efficient and inexpensive way of collecting wide-ranging information about end users' view of technological systems.

Strength and Limitations

This conceptual framework has its strengths and limitations. The TAM has been more popular than the relatively newer UTAUT in evaluating and implementing health care information technology systems and other programs (Cheung & Vogel, 2013; Khan

& Woosley, 2011; Pai & Huang, 2011). The TAM is regarded as a broad but well-established technology model (Gagnon et al., 2014; Tsai, 2014). Cheung and Vogel (2013) pointed out that the TAM is identified as one of the best models applied in both IT systems and in methodologies that are being used to clarify technological systems.

Several researchers have validated TAM's effectiveness in understanding the role of human behavior in implementing and sustaining information technology. For example, Edmunds, Thorpe, and Conole (2012) used the TAM to assess the attitudes and techniques used in and out of school. Edmunds et al. concluded that the TAM remained sturdy in its evaluative ability on IT. Further, TAM concepts have been shown to have a robust impact regarding the intention of IT users in government operations (Lin et al., 2011). These findings indicated that the key constructs in TAM could be used to predict the success or failure of a given IT project in any given setting. However, some of the early critics pointed out that the TAM had questionable exploratory or investigative significance and that it had limited predictive ability (Bagozzi et al., 1992). Nevertheless, Ketikidis, Dimitrovski, Lazuras, and Bath (2012) acknowledged health care technology evaluation as a relatively new practice and the scarcity of well-developed theories in this area. Because the TAM model can be used as a guide to explore a setting (Peek et al., 2014), it was used in the current study as a framework for interviews and document reviews.

Trend in Health Care Information Technology

Technological information systems used in health care are relatively new compared to those used in other disciplines. Nevertheless, the adoption of HIT has seen

dramatic progress in patient safety through automation of services such as discharge process, medication prescription, dispensing and administration, storage of drugs records, and other positive outcomes over the years (McCullough et al., 2016). This trend provides some hope for reducing medical errors, the rising cost of healthcare, and increasing demands for patient satisfaction to mention a few. Many stakeholders, including government agencies, have joined the national efforts to improve health care using technology. Equally, some studies have validated the *Meaningful Use* Incentive Program offered by the federal government on several HIT systems such as BCMA implementation in some health care centers (Jones et al., 2014; Poon, Keohane, & Yoon, 2010). This government financial assistance program has created much interest among government agencies, especially when evaluating the implementation of a HIT, prompting multiple research studies (Poon et al., 2010). Some studies have shown that little or no improvement with HIT implementation exists, such as in the case of Computerized Physician Order Entry (CPOE) (Schwartzberg, Ivanovic, Patel, & Burjonrappa, 2015). However, several studies have employed qualitative method designs to highlight the benefits that come with most HIT systems, such as BCMA (Simon et al., 2013).

Medication Errors and Patient Safety

Patient Safety

The safety of the patient is a global issue and is not a single hospital's problem (Aiken et al., 2012). This stance has prompted various health and governmental organizations to increase their patient care standards, including the adoption of national

accreditation standards like those promulgated by The Joint Commission. For example, healthcare institutions are increasingly developing the culture of patient safety by adopting those evidence-based practices that promise to cut down adverse effects (Wang et al., 2014a). Some experts also argue that HIT application systems that are meant to prevent errors in health care could also easily harm patients (Bonkowski, 2013; Van Den Bos et al., 2011). It is not uncommon to see unnecessary deaths occurring due to medical harm year after year (Tzeng et al., 2013). By 2011, over 98,000 incidents of medical harm resulted in death with about 38% of the fatalities related to medication errors (Classen et al., 2011). These statistics have prompted organizations and government agencies such as AHRQ to provide financial assistance that goes towards research involving patient safety (Wang et al., 2014b). Substantial evidence supports the use of clinical decision support with the help of computerized systems such as provider order entry and BCMA (Jones et al., 2014). However, insufficient reporting of implementation and context of use makes it impossible to conclude whether some health IT implementations are successful or not. Nor has there been systematic explorations of how systems fare in the period following initial implementation and evaluation. The most important improvement that can be made in healthcare IT evaluations is increased reporting of the effects of application and context (Jones et al., 2014).

Medication Errors

Medication errors continue to be one of the major concerns regarding patient safety in a healthcare setting (Keers, Williams, Cooke, & Ashcroft, 2013). Errors that occur when using BCMA technology are primarily due to a number of reasons. They

include; (1) barcode malfunction, (2) network connection errors, (3) a progressive error, (4) staff failure to properly use the scanner or overlook the scanner warnings, and (5) system failures (Debono et al., 2013). Other cited reasons, why errors occur, are improvisations created by nurses or organizational culture (Alomari, Wilson, Davidson, & Lewis, 2015; Debono et al., 2013; Voshall, Piscotty, Lawrence, & Targosz, 2013). Whereas improvising could be helpful at times, it can have devastating effects including harm to the patient (Debono et al., 2013). An example of system failure is when a doctor frequently makes errors during prescribing which are then perpetuated to the pharmacy when dispensing and finally, to the nurse when administering the medication and following up on the patient response to the drug (Midgley et al., 2013). In this situation, staff nurses have little or no control. Nursing management, together with information technology department, could hold the answers to this problem. Studies have reported that over 25% of medication errors occurring during medication administration is mainly due to nurses giving patient medication at the wrong time, omitting some doses, or giving wrong dose (Keers et al., 2013). These challenges point out the need to have safe and efficient technological systems that enhance medication ordering, prescribing, administration, and follow-up.

Bar Code Medication Administration

Many cases of medication errors reported in the U.S., over the years, have prompted a national effort to come up with some strategies to contain this menace (Wang et al., 2014b). One of the approaches includes the use of health technology systems like Barcode Medication Administration (BCMA). The BCMA system is currently a major

healthcare technology that has increased not only patients' safety and operation efficiency but also confidentiality and hospital expenses associated with care delivery (Aiken et al., 2012; Voshall et al., 2013). Some studies have not shown a significant decrease in medication errors after implementing BCMA (Choo, Johnston, & Manias, 2014). However, many studies have revealed the BCMA system's effectiveness in lowering the number of reported errors (Bonkowski, 2013; Classen et al. 2011; Pedersen et al., 2012; Poon et al., 2010; Tzeng et al., 2013). In U.S., about 65.5% of registered hospitals had employed BCMA by the year 2012 (Pedersen et al., 2012). This trend has resulted in a reduction of medication errors of almost 80% in most hospitals (Bonkowski, 2013; Weston & Roberts, 2013). Additionally, this data suggests that BCMA is an important healthcare technology that cannot be ignored and its benefits need to be optimized and sustained. Moreover, most of these studies and reports have highlighted the safety outcomes of BCMA technology and have advocated that the technology needs to be implemented, optimized and sustained in other hospitals (Van de Glind et al., 2012). Further, other studies have presented the statistics that support the reasons why BCMA technology is useful and how continuous evaluation criteria could benefit the overall health care system utilizing this technology (Bonkowski, 2013; Weston & Roberts, 2013). However, those hospitals utilizing this technology might be under threat should they lack appropriate implementation action plans from top hospital management down to clinical end users (Classen et al., 2011). Additionally, these studies have revealed some gaps in the literature that focus on the role of nurses and their leaders in sustaining the BCMA technology (Weston & Roberts, 2013).

A recent analysis of occurrence reports indicated that 43.4% of medication errors occur at the time of administration despite the use of BCMA (Yang & Grissinger, 2013). This observation may imply that there is some form of workaround that could later lead to sub-optimization of BCMA technology undermining its success and sustainability. Thus, there is a need to understand the nurses' approaches such as attitude towards using the system and toward the success of BCMA technology. The literature has not revealed studies that have examined action plans or approaches laid down by nurses and their leaders to sustain the BCMA technology and maximize its benefit. This weakness has created a gap in literature promoting the formulation of the above dissertation topic. The general problem is that research studies that have looked at the action plan put forward by hospital leadership for implementing and sustaining BCMA technology are negligible, hence, the relevance of this study. The specific problem is that clinical nurses and nursing leadership, in collaboration with hospital leadership and IT, lack strategies to ensure maximum use of BCMA technology and the plans to sustain this technology in acute care units.

Nurses as BCMA End Users

Nurses are usually the primary end users of most Health Information Technology (HIT) systems such as Electronic Medical Record (EMR) and Barcode Medication Administration (BCMA). Therefore, they require continuous support not only to implement these HIT systems successfully (Novak et al., 2012) but also to improve safety and prevent unintended patient harm (Moss & Berner, 2015). Recent exploratory studies reveal that nurses' support on HIT use has focused more on adoption, technical

assistance, and usability for a HIT (Zahabi et al., 2015). However, there are no adequate or straightforward approaches adopted by clinical nursing staff and their leaders to ensure proper use and sustainability of HIT such as BCMA (Shachak et al., 2013; Zahabi et al., 2015). Consequently, some studies have recommended that future efforts should place more emphasis on among other things, understanding of nurses' preferences, needs, concerns, adaptation, and expectations regarding a given HIT technology (Park, Chen, & Rudkin, 2015; Taliercio et al., 2014). The end-user support is a multifaceted issue that may vary significantly, contingent on clinical workflow, use of a given HIT system, and related influences (Moss & Berner, 2015). Thus, nurses and their leaders need to understand and clearly define their best approaches on continuous BCMA use, its optimization and evaluation criteria (Kuziemsky, 2014; Shachak et al., 2013). This move is primarily important if nurses want to successfully reap the benefits of a given HIT system and sustain its use. Maximizing and maintaining the use of BCMA will also create a culture of safety (Kelly et al., 2016).

Summary and Conclusions

This chapter focused primarily on the literature review. The literature review revolved around the following eight themes: Role of conceptual frameworks, Technology Acceptance Model (TAM), the trend in Healthcare Information Technology (HIT), medication errors and patient safety, Bar Code Medication Administration (BCMA), nurses as end users, and nature of the study. The TAM and its related concepts and propositions were discussed. The concepts of perceived usefulness and perceived ease of use work independently to influence one's attitude regarding the use the technology while

at the same time perceived ease of use influences perceived usefulness. To answer the research questions, the subsequent chapter will review the nature of the study, research design, and rationale. The chapter will also touch on methodology where participants and their selection, the location of study, instrumentation, data collection analysis, and ethical consideration will be discussed.

Chapter 3: Research Method

This study was conducted to understand the approaches that participant nurses and their leaders have employed to ensure proper use of implemented BCMA technology and its sustainability in acute clinical care units. The study was conducted to enrich the literature on technological health care systems. This was necessary because very little was known about how to maximize BCMA technology and sustain it for the safety of patients (Shachak et al., 2013; Zahabi et al., 2015). Specifically, the literature did not reveal studies that addressed action plans or approaches by nurses and their leaders to sustain BCMA technology and maximize its benefits such as patient safety, satisfaction, and cost-effectiveness. This chapter includes the nature of the study, research design, and rationale. I explain participant selection, the setting of the study, instrumentation, data collection, data analysis, and ethical concerns.

Nature of the Study

I used a qualitative case study approach including semistructured interview questions to collect data from end users of BCMA technology. A case study approach involves intensive study of a group, individual, or situation (Lincoln & Guba, 2002; Sangster-Gromley, 2013). The emphasis on how individuals perceive, believe, and perform or behave is more practical and accurate when such individuals share their experiences in a case study (Baxter & Jack, 2008). Simon et al. (2013) provided a rationale for the use of a qualitative approach in the evaluation of HIT systems. Several other researchers have employed a case study approach investigating health care technologies that are relatively new (Simon et al, 2013), exploring newly implemented

nursing interventions (Baker, 2011; Van de Glind's et al, 2012), and conducting a systematic and rigorous examination of real-life circumstances (Cronin, 2014; Verner & Abdullah, 2012). These studies informed the choice of a case study design to answer the current research questions .

Research Approach

I sought to answer two research questions: (a) What are the nurses' perceptions on the use and optimization of BCMA system and patient outcomes? (b) What approaches do clinical nurses and nursing leadership have in place to ensure that the applied BCMA technology is properly used and sustained in the acute care units?

I used a qualitative case study approach. A case study is a form of inquiry used to understand an up-to-date occurrence in a real-life setting (Yin, 2013). I developed semistructured interview questions to collect data from hospital leaders and nurses who are end users of BCMA technology. Simon et al. (2013) provided a rationale for the use of a qualitative study in the evaluation of HIT systems. Further, Simon et al. recommended the use of case study approach for exploratory studies involving health technology systems that are relatively new. Van de Glind et al. (2012) recognized the case study as a strong research approach for implementation of nursing interventions. Van de Glind et al. also emphasized the need for additional case studies for hospital-related program implementation. These studies informed the choice of a case study approach to answering the current research questions. A qualitative approach with a case study design involves intensive study of a specific group, individual, or situation. There are many ways to carry out a case study, and a combination of approaches is often

applied such as unstructured interviews, direct observation, and conference meetings (Creswell, 2012).

A case study is often challenging (Yin, 2003a), but has become a common strategy in health care research (Carolan, Forbat, & Smith, 2016). Although other qualitative approaches like ethnography, descriptive phenomenology, and grounded theory were considered, I preferred a case study approach. A significant reason why a case study approach was chosen was that it allowed the use of several sources and procedures during data collection (Baxter & Jack, 2008). A qualitative case study is a strategy that enables a researcher to explore and describe significant themes regarding a phenomenon of interest within its environment using one or more data sources (Baxter & Jack, 2008; Van de Glind et al., 2012). Additionally, a case study is flexible and has applicability to real-life situations (Yin, 2013a), where participant perceptions, views, knowledge, and positions can be reported precisely and truthfully (Van de Glind et al., 2012). Another reason that made a case study appropriate was that it had been used in many studies to evaluate health care projects following implementation (Baxter & Jack, 2008). Results generated from the current study may reflect the everyday practice and real-life experiences of nurses as the end users of BCMA technology.

Other Approaches

A descriptive phenomenological approach permits the investigator to explore, analyze, and describe a phenomenon that provides a real picture of lived skills, knowledge, and experiences (Giorgi, 2009; Matua & Van Der Wal, 2015; Wertz, 2005). A phenomenological approach could have been used to explore and describe the nurses'

experiences when using BCMA technology. However, a case study approach was more appropriate to explore the progression and in-depth subjective scope of experiences of the individual nurses as they lived the medication administration practice in their units.

Researchers using the ethnographic approach strive to understand and make sense of a culture in a social setting (Garner & Scott, 2013). Ethnographers use participant observation as the primary strategy to gather data (Morse & Richards, 2002).

Ethnographic researchers need to be physically and socially engrossed in a cultural group for an extended period (Cruz & Higginbottom, 2013). Although nursing could be considered a culture group, examining nurses' lived experiences while using barcode medication administration did not include a cultural aspect. Therefore, this approach was deemed inappropriate for this study.

The grounded theory approach provides a progressive strategy with the aim of developing, verifying, or improving a theory of a phenomenon (Glaser & Strauss, 1967). When using this strategy, the researcher analyzes field notes, documents, proceedings, and interviews (Morse & Richards, 2002). The aim to generate, improve, or verify a theory indicated that grounded theory was not appropriate for the current study. Also, grounded theory was found to be unsuitable based on the research questions in this study.

Methodology

Participant Selection

Participant selection in qualitative research is essential in achieving the objectives of the study (Newington & Metcalfe, 2014). A purposeful sampling method was used in this research project. The target population comprised nurses and nurse leaders who are

end users of a BCMA system. The sample included participants who are currently and actively using this technology in the acute patient care environment. According to Newington and Metcalfe (2014), the participation rate is enhanced by reducing the burden on potential volunteers. To increase the participation rate in this study, I used employee work e-mails. This approach was a more convenient way to reach this group of employees. Fifteen participants were recruited for face-to-face interviews. Reaching data saturation was the primary goal (Fusch & Ness, 2015). Saturation is a point when no observable evidence of new themes or information emerges during the data collection process (Guest, Bunce, & Johnson, 2006). It is, therefore, not practical to determine the sample size before the start of data collection (Guest et al., 2006). Nevertheless, obtaining a required sample size is a requisite to the success of qualitative clinical research (Robinson, 2014).

Location and Recruitment Plan

Qualitative researchers usually define a site-specific procedure to locate, select, and recruit participants (Arcury & Quandt, 1999). The data were collected from a large hospital which is an academic medical center and one of the largest hospitals in Dallas, Texas. This medical center handles around 100,000 hospitalized patients, 600,000 emergency cases, and almost 2.2 million outpatients yearly. This hospital has a workforce of over 16,000 employees and nearly \$3.0 billion in operating budget. The study participants included a purposive sample of between 10 and 15 individuals. Eight participants completed the interview successfully. A sample of about 8 to 15 participants is small but adequate when it comes to a case study design (Molenberghs et al., 2014).

The participant pool comprised staff nurses and nurse leaders. This sample was chosen considering several factors including accessibility, continuity of services, lack of vulnerability, and the ability to provide firsthand information on the use and sustainability of the BCMA system. Participants were invited to interview by use of e-mail. The medical center's office of education and research assisted in reaching out to targeted nurses using an employee e-mail database. The expected number of nurse volunteers responded to the e-mail, so no other approach was employed. One of the planned alternatives was to visit several acute care units to recruit the desired number of nurses who use a BCMA system. Selection criteria included that the nurse be working in one of the medical care units within the hospital and be a current or recent user of BCMA technology. The participants agreed to take part in one-on-one interviews lasting between 30 and 60 minutes.

Before the interview, each participant was given an informed consent form for review and was given opportunities to ask questions before accepting the role of a participant. The reasons for conducting the study and the benefits were explained to the participants in plain language. I also explained confidentiality issues. Each participant was given a number and was assured that no individual identifying information would be collected to ensure confidentiality. Collected data would be stored in a computer accessible only by me for a period not exceeding 5 years per Walden University regulations. Additionally, the participants were informed of their right to withdraw from participation at any time during the study if they chose to without any consequences.

Role of the Researcher

In a qualitative case study involving interviews, the investigator functions as the instrument or tool for data collection (Fink, 2000; ter Bogt & van Helden, 2012). One of my roles as a qualitative researcher was to collect the data as described in the data collection plan. As a person entitled to carry out the research study, I participated in every stage of the investigation process. In this role, I ensured that personal bias, such as expectations, personal experiences, and assumptions, was addressed. I ensured that participant information not pertinent to the study was not collected. Recognizing and mitigating personal bias is a part of research to enhance trustworthiness (Noble & Smith, 2015). My role was an objective observer. I endeavored to let the case speak for itself to minimize subjectivity and remain a participant observer as recommended by Baxter and Jack (2008). Additionally, my role involved designing, interviewing, transcribing, analyzing, verifying, thematizing, and reporting (Fink, 2000). Regarding verification, my primary concern was to provide truthful and accurate information to draw a proper interpretation of the case as supported by Baxter and Jack (2008). A researcher can improve trustworthiness by obtaining respondents' validation (Morse, 2015b; Noble & Smith, 2015).

Instrumentation

The goal of qualitative inquiry is to discover and obtain detailed information about the participant and issues surrounding the topic of interest (Jacob & Furgerson, 2012). Therefore, closed questions are not appropriate (Potter & Hepburn, 2005). I developed open-ended interview questions to conduct this case study. Jacob and

Furgerson (2012) supported the idea of the interviewer starting with general, basic, and comfortable questions to answer. This approach can encourage the participant to relax and freely give his or her thoughts and ideas. Other techniques advocated by qualitative experts include using prompts, keeping the interview focused, and conducting the interview in a quiet and private location (Jacob & Furgerson, 2012; Mellon, 1998; Potter & Hepburn, 2005). Also, using short questions and focusing on listening is encouraged (Weiss, 1994). I audiotaped the interviews to encourage free interaction between myself and the participant and accurate retrieval of information during transcription. Researchers are encouraged to use interview questions as a guide so that follow-up questions and prompts can be revised during the interview process (Jacob & Furgerson, 2012).

The interview questions were developed considering the above factors and aligning the research questions with the TAM. Technology experts widely recognize the TAM in explaining the implementation, adoption, and acceptance of any given technological system (Lorenzo-Romero, Alarcón-del-Amo & Constantinides, 2014). The TAM proposes that the way users perceive the usefulness and ease of use of a given technology may affect their attitude toward using and in turn predict their intention to use and adoption of a technological system (Davis, 1989). External factors can influence the way technology users feel about the usefulness or ease of use. The key concepts in TAM include *perceived ease of use (PEOU)* and *perceived usefulness (PU)* which could separately sway an individual's attitude towards the system use. The attitude is a tendency to positively or negatively responding towards something (Bhattacharjee & Lin, 2015). While perceived usefulness is the extent to which an individual is certain that

using a given technology system will augment a task he or she is involved in (Davis, 1989). Another concept in TAM model is the *perceived ease of use*. This factor signifies the extent/scope to which an individual considers whether a technological system would be employed with little or no effort (Lorenzo-Romero et al., 2015).

To answer the two research questions for this study, I used six questions (Appendix C). As stated above, these questions aligned with the major TAM's concepts of perceived ease of use, perceived usefulness, and behavioral intentions to use (Davis, 1989). Additional questions were used as prompts or as follow up questions when the interviewer thought that more information was needed to clarify the participant's responses. The questions were designed to seek the answers that would explain the nurses' level of preparedness, the concept of perceived usefulness, the concept of perceived ease of use, and the attitude or behavioral intentions to use of BCMA technology.

Question 1 was used a general lead intended to make participants relax and express thier understanding about the technology as they view, know, and use it. It was used to provide participants' views, opinions, and perceptions from general to specific (Jacob & Furgerson, 2012). Question 2 was designed to uncover the level of preparedness, training, and resources of the nurse to use the technology hence perceived ease of use or not to use it. It was also expected to reveal some of the external factors that nurses believe they affect the use of this technology. Question 3 was intended to unearth how nurses feel about the benefits, worthiness, or usefulness of the BCMA technology system -perceived usefulness. Question 4 was designed to discover what nurses believe

could be the impediments and barriers to maximizing/optimizing the benefits of the BCMA technology system. Question 5 was used to unveil those strategies/approaches that nurses are utilizing when using the technology to administer medications. The question was also used to reveal nurses position as to whether their strategy/approach to using the BCMA technology was effective and sustainable or whether they needed new plans and procedures. Lastly, question 6 was included to give the participants an opportunity to add or contribute any data that the researcher may not be aware of.

Sample Size

Unlike quantitative research studies, qualitative studies utilize a relatively small number of participants (Marshall, Cardon, Poddar & Fontenot, 2013). However, the sample size is determined by numerous factors such as sampling methods, the study purpose, and time available to conduct the research just to mention a few (Patton, 2015). According to O'Reilly and Parker (2013), a sufficient number of the informants is dependent on the research focus and the expenses associated with a given study. Further, O'Reilly and Parker reiterated the issues of suitability, relevance, and sufficiency as essential ingredients in the choice of sample size and sampling method. It follows that the researcher, as the designer of the study, typically carries the burden of determining which sample size is adequate and relevant (O'Reilly & Parker, 2013). To sufficiently answer the study question, the data was collected until saturation was reached (Fusch & Ness, 2015; O'Reilly & Parker, 2013). Obtaining data from multiple sources through the process of triangulation could heighten not only the reliability of the findings but also data saturation (Fusch & Ness, 2015). Although the primary source of data was through

participants interviews, information was also collected from memos and institution policies related to technology system under investigation. This study was conducted within a period of one-month. Nurse participants and leaders working in the same facility were interviewed.

Sampling Strategy

Several sampling procedures can be applied in qualitative research. The purpose of qualitative study may dictate which sampling procedure to utilize (Patton, 2015). These strategies include among others, intensity sampling, homogeneous and heterogeneous sampling, typical case, purposeful sampling, criterion case, and extreme case (Acharya, Prakash, Saxena, & Nigam, 2013; Patton, 2015). This study employed purposeful, convenience sampling. In this non-probability sampling, one case (hospital) was conveniently chosen among the seven large health care organizations that utilize Barcode Medication Administration technology within the greater Dallas-Fort Worth metropolis. Non-probability sampling is principally suitable for fact-finding or exploratory research (Curtis, Gesler, Smith, & Washburn, 2000; Tansey, 2007), such as in examining challenges and strategies that nurses face when using BCMA technological system proposed in this study. Curtis et al. (2000) argued that, with use of purpose sampling, a wide range of sampling techniques can be employed. Since only nurses with the practical and theoretical knowledge and who are experts in barcode medication technology were selected, the investigator specifically employed expert sampling technique. The choice of nurses as participants that provided detailed facts was informed by feasibility factor suggested by Miles, Huberman, & Saldana (2013). The cost

regarding time and money and compatibility of the researcher with the participant is an important aspect when selecting a sampling technique (Miles et al., 2013). The investigator in this study has worked in the hospital environment and thus, was able to understand and relate well with nurses and their leaders.

The purposeful, convenience sampling strategy is less expensive (Tansey, 2007). It is also commonly used, and a listing of all the population elements is not necessary (Acharya et al. 2013). Although the sample size was relatively small in this study, credibility was safeguarded (Burmeister, & Aitken, 2012). To enhance triangulation, reliability, and saturation, information contained in the institutional policies regarding the topic under investigation was also collected. Non-probability sampling, such as purposive sampling comes, with some limitations (Robinson, 2014). Since the choice of sampling technique is based on investigator's judgment, is possible for the study to draw criticism regarding researcher's bias (Acharya et al., 2013). With non-probability sampling, it is hard to control or measure bias together with variability (Acharya et al., 2013). Additionally, transferability of findings from the data collected using this strategy is customarily limited or nonexistent outside the sample under investigation (Acharya et al., 2013; Schwandt, Lincoln, & Guba, 2007).

Data Collection

Instrument

An interview guide was used to carry out this study. This interview guide consists of six semi-structured interview questions (Appendix C). Individual participants from a group of experts (nurses and their leaders) were selected and interviewed. These

participants were chosen from a selected hospital within Dallas Fort-Worth metropolitan area. The form of the interview was a face-to-face oral interview. As an interviewer, I acted as a tool for data collection (Fink, 2000; Ter Bogt & van Helden, 2012). During the conversations, I ask follow-up probes, wrote some notes, and audio recorded the interviews after obtaining the necessary consents from participants. The review of the literature and the nature of research questions guided the choice of the interview and data collection tool as explained by Rabionet (2011). Three participants agreed to participate in member checking of the data and preliminary results as explained in the section below.

Field Testing

Unlike in quantitative inquiry, where a researcher can statistically test the validity and reliability of questions, qualitative researcher field checks the instrument (Turner III, 2010). In this study, interview question guide was field tested strategically by selecting three individuals who are expert in both nursing and barcode medication technology system. The experts gave feedback on the suitability of those questions about the proposed sample and study topic (Turner III, 2010). Since the selected experts did not provide answers to the interview guide questions, no data was provided at this juncture. Instead, these experts offered information that improved and refined the interview guide. This process minimized the possibilities of bias, repetitiveness, and ambiguity (Turner III, 2010; Van Teijlingen & Hundley, 2002).

Member Validation

Member checking involves sharing some of the study results with participants (Varpio, Ajjawi, Monrouxe, O'Brien, & Rees, 2017). This approach is an essential

qualitative technique designed to confirm accuracy and consequently augment research credibility of research findings (Goldblatt, Karnieli-Miller, & Neumann, 2011; Lincoln & Guba, 1986). To increase the credibility of data analysis, the participants were presented with the data transcripts and preliminary results and then asked to confirm the investigators' interpretations of the data. Any discrepancies that were pointed out by the participant were used to correct the mistakes. Thus, eliminated the possibility of data misrepresentation and wrong interpretation (Varpio et al., 2017). Caution was taken to maintain the privacy of participants (Goldblatt et al., 2011).

Justification

The interview is undoubtedly the most frequently employed method when collecting qualitative data (Kasper & Prior, 2015). In recent times, different qualitative interviewing techniques have been acknowledged as practices where people collect the data (Lippke & Tanggaard, 2014). Most qualitative authors agree that there are no interviewing methods that are better than the others (Opdenakker, 2006). Face-to-face interviews have traditionally been used more regularly than any other method (Opdenakker, 2006). Opdenakker (2006) reiterated that the choice of the interviewing technique predominantly relies on the type of the data needed. Nevertheless, the emergence of efficient information technology has seen more and more qualitative researchers adopting other interviewing strategies such as video conferencing via the internet, e-mail, and telephone interview just to mention a few (Opdenakker, 2006). Telephone interviews can take shorter periods covering more questions and access to individuals from a wider geographical area compared to interviews conducted face-to-

face (Irvine, 2011; Opdenakker, 2006). Additionally, Novick (2008) cited factors such as participants feeling comfortable during interview and ability of the respondents to reveal sensitive information as essential benefits for telephone interviews. All participants were selected from one hospital; hence, a phone interview was not necessary. Also, participants agreed to attend a face-to-face interview as proposed in this study.

One of the major objectives of a researcher is to get a detailed and truthful information from the participants (Rabionet, 2011). Semi-structured questions as a data collection tool provoke thinking and challenge the respondents to give more focused and accurate information without having a feeling of *interviewer controlled* conversation (Whiting, 2008). Whiting (2008) also believed that semi-structured qualitative questions could be the best instrument to gather information regarding health care practices to evaluating a program. Such a tool, according to Rabionet (2011), enables the researcher to attain general data and an array of insights appropriate to the particular problem under investigation.

Data Analysis Plan

The case study can produce an enormous amount of data that will be subjected to analysis (Baxter & Jack, 2008). During the data analysis, close attention was paid to new chances, themes, and insights. The case study approach can utilize various data collection techniques and analysis methods. Thus, investigators can triangulate data and strengthen the research results and conclusions (Fusch & Ness, 2015; Lewis, 2015). Participant interviewing and collection of institution documents such as policies and memos provided the data in this study. In this section, the explanation of data analysis strategies

is given, interpretation plan provided, and justification for using NVivo computer software is elucidated.

Data Analysis Strategies

Data management and coding are not only necessary before and during the research period, but also after the study is performed (Johnson, Dunlap & Benoit, 2010). Qualitative student researchers are therefore encouraged to increase the usage of qualitative data analysis software (QDAS) programs available in the market (Creswell, 2012; Woods, Paulus, Atkins & Macklin, 2015). This approach is primarily essential when organizing the data from sources such as newspapers, movies, sitcoms, e-mail traffic, and so on (Idreos, Papaemmanouil & Chaudhuri, 2015). Further, using QDAS ensures quick retrieval when cross-referencing and at the time of data coding or analysis (Woods et al., 2015). While there are various QDAS in the market today (Miles et al., 2013), the assessment and final choice of a particular software tool are essential when it comes to choosing a preference on methodology (Saillard, 2011). In this study, NVivo will be used to organize data logically in addition to other tools such as USB flash disc, and Google doc which may circumvent the loss of data and enhance easy access. Interview transcripts were inductively reviewed before manual coding was started. Coding qualitative data is undoubtedly a good form of organizing the collected relevant information such that retrieval could be easy, according to Fereday and Muir-Cochrane (2008). Fereday and Muir-Cochrane (2008) noted that this strategy also sets the stage for an efficient data analysis. That is, discovering recurring patterns and revising the data to ensure its accuracy as described by Houghton, Murphy, Shaw, and Casey (2015). This

procedure aimed to explore the meaningful content of collected information by looking for emerging themes. I will mark the keywords and phrases with different colored highlighters initially as recommended by Ryan and Bernard (2003) and later identify the keywords, phrases, and ideas emanating from the interview using NVivo.

Justification for Using NVivo

According to Johnston (2006), qualitative data analysis software (QDAS) is essential in facilitating the process of achieving rigor in qualitative studies. For the most part, this quality is needed to maintain uniformity during the coding process (Johnston, 2006). The task of choosing the most appropriate software for qualitative research can be daunting since there are many in the market (Cretchley, Rooney, & Gallois, 2010). Qualitative research software includes but is not limited to the ATLAS.ti, MAXQDA, and NVivo. None of these tools are found to be better than the other, and they are created to assist qualitative researchers in managing and analyzing the data (Franzosi et al., 2013). However, some notable differences and similarities in their functionality exist. Both ATLAS.ti and MAXQDA import memos without limiting the length of the note (Schmieder, 2015). Although NVivo is at times labor-intensive (Sotiriadou, Brouwers, & Le, 2014), it was used in this study. This choice was essential since I had learned most of its functionality and tool that has features that link the input data to recognize the relationship between ideas and the possible themes emerging from them (Talanquer, 2014). These features were also essential when dealing with data collected from semi-structured interviews (Talanquer, 2014). The NVivo software tool like the other main QDAS is well established such that the choice of its use depends on researchers'

preference and few notable and positive differences in features found in it but not found in other QDAS (Bandara et al., 2015).

Interpretation Plan

In this study, six open-ended questions were developed to function as a tool to guide the interview after which NVivo computer software was utilized to assist in sorting out themes. Emerging themes were grouped into major and minor categories. Themes were expected to develop around the areas of communication, technology support, training nurses, and policies. This position was held because such similar approaches are consistent with various applied health technologies, and all expert participants could easily relate to them (Cifuentes et al., 2015; Kellermann & Jones, 2013). However, a keen interest was taken to see any unexpected themes developing after reaching data saturation.

Issues of Trustworthiness

This study took the issues of trustworthiness seriously. Trustworthiness and quality in qualitative research can be achieved when researchers strive to attain and pay close attention to concepts of evaluating quality (Lincoln & Guba, 1986; Creswell & Poth, 2017). That is dependability, transferability, credibility, and conformability. Some writers regard qualitative research as small-scale and lacking in rigor (Anderson, 2010). Knowing the limitations, assumptions, and biases affecting the study results can increase credibility or transferability of the data to a different setting (Creswell & Poth, 2017; Mehra, 2002). Although it can be challenging to maintain, evaluate, and prove trustworthiness in qualitative research, following all necessary steps could improve

acceptance when it comes to credibility (Morrow, 2005). One way that was used to establish rigor in this study was to allow the respondents to evaluate the data and preliminary analysis and report back their feedback regarding my interpretation as Anderson (2010) advocated.

Credibility

Credibility, which is defined as the confidence in the accuracy of the research results is an essential aspect of qualitative studies (Anderson, 2010; Goldblatt, 2011; Lincoln & Guba, 1985). The participants' opinions rather than researcher's understanding of the subject were presented (Varpio et al., 2017). As noted earlier in this chapter, the credibility of findings is enhanced when the researcher provides an accurate reflection of the participant's worldviews (Vivar, McQueen, Whyte, & Armayor, 2007). The accuracy of findings was safeguarded by conducting member checking. Member checking encompasses sharing some of the results of research with participants (Varpio, Ajjawi, Monrouxe, O'Brien, & Rees, 2017). To increase the credibility of data analysis, a researcher in this study involved a few participants. The participants were presented with the data transcripts and preliminary results and then asked to confirm the investigators' interpretations of the data. Any discrepancies pointed out by the participants were used to correct the mistakes and removed the possibility of falsification and wrong interpretation of data (Varpio et al., 2017). Just like in the initial interview, the technique was carried cautiously, and care was taken to maintain the anonymity of participants (Cope, 2014; Goldblatt et al., 2011). There was no observed harm connected with member checking in

this study. A review of documents such as policy offered an opportunity for data triangulation, hence increased the credibility of the findings

Transferability

Generalizability of findings is a well-understood feature and a standard quality aspect in quantitative research (Polit & Beck, 2010). However, transferability, as applied in qualitative inquiries, is multifaceted and is not well understood (Burchett, Mayhew, Lavis, & Dobrow, 2013). The objective of qualitative studies is not to take a broad view as in the case of generalization in statistical inquiries (Polit & Beck, 2010). Studies utilizing either quantitative or qualitative study are held to the same high standard to add knowledge and improving practice. As such, researchers in qualitative studies need to demonstrate that a rich and contextualized understanding of human experiences and knowledge were obtained by thoroughly studying specific circumstances and cases in their natural setting (Yin, 2013b). To ensure that this study can be replicated in the future, a detailed data collection procedure was explained. Field notes that described observations and experiences with the informants were maintained. These field notes were used to supplement audio-recorded interview data hence, became part of the data analysis procedure (Mulhall, 2003). Any variations in participants were described fully. In this study, the same interview questions were applied to all respondents, consistently analyzed the data using a one computer software, in this case, NVivo.

Confirmability

Confirmability refers to the extent of impartiality or the scope to which the results of a study are molded by the participants devoid of investigator preconception, interest or

motivation (Anderson, 2010). Similarly, researchers need to confirm and establish that the results and conclusions presented does not include their biases, but respondents' correct responses (Anderson, 2010). This approach according to Cope (2014) ensures adherence to credibility and confirmability. In this study, the researcher included direct quotes from participants that portrayed developed themes (Cope, 2014). The investigator also conducted member validation with participants to confirm the accuracy of findings. Trustworthiness can be improved by keeping the representativeness of the results related to the study questions as accurate as possible (Lincoln & Guba, 1986; Merriam & Tisdell, 2015). Also in this study, accuracy was enhanced by maintaining audio recorded semi-structured interviews attained from respondents. This method enabled the researcher to review the data frequently and thoroughly for any developing themes and uphold original participants' perceptions about Investigation.

Dependability

Dependability can be achieved by showing that findings are consistent and that similar results would be found if a different study employing the same techniques, context, and method were to be conducted (Miles et al., 2013). This quality is usually difficult to achieve owing to the shifting nature of the phenomena studied by qualitative inquirers (Lincoln & Guba, 1986; Merriam & Tisdell, 2015). Because of the closeness between credibility and dependability, an investigator can demonstrate that a study is indeed dependable if credibility established (Creswell & Poth, 2017; Lincoln & Guba, 1986, Merriam & Tisdell, 2015). Another way to address dependability is to ensure the study is reliable (Shenton, 2004). It follows that this study addressed the issue of

dependability by conducting member checking, field testing, detail explanation of methodology, and all other aspects that establish trustworthiness.

Ethical Consideration

Three moral principles should guide research involving human subjects: (1) justice, (2) beneficence, and (2) respect for the person (Creswell & Poth, 2017). This study was sensitive and adhered to all procedural and policies guiding the organization (study site) and Walden University policies regarding ethical practice. When it comes to the interview, I addressed the aspect of decreasing the danger of unexpected harm to the participants. It was my duty with assistance from the university research office, to shield all the participants from any harm. I notified participants fully about the nature of the study and any rights and risks associated with it. Walden university office of research and the institution where I collected the data assisted in providing the necessary review of the protection of all participants. A letter that served as an informed consent was given to all participants, and an opportunity to ask any concerns was provided before they participated in the interview process.

Walden University's Institutional Review Board (IRB) reviewed my adherence to all ethical standards and approval (number 04-20-17-0462223) made before data collection. The permission to collect the data from the participants was also obtained from the institution where these participants are located (Appendix A & B). As the researcher, my sole responsibility was to access and manage the data in a manner consistent with both the University and institution IRB expectations. Information collected was stored in password-protected computer and will be kept for a period not

exceeding five years according to Walden University regulations. Participants were informed of their right to withdraw from participation at any time during the study process if they chose to without any consequences on their part. Since I am not an employee of this institution where the data was collected, there was no conflict of interest about participant's work location. There were no incentives offered to any of the respondents.

Summary

This study was designed to understand the kind of approaches that nurses and their leaders have employed to ensure the proper use of implemented BCMA technology and its sustainability in acute clinical care units. To examine these approaches, this Chapter has detailed among other things the methodology of the method of inquiry and study design. The review of the nature of the study, research design and rationale were discussed. The chapter also touched on methodology where participants and their selection, the location of study, instrumentation, data collection analysis, and ethical consideration will be discussed. This study utilized six open-ended questions developed to function as a tool to guide the interview after which NVivo computer software was employed to assist in sorting out themes. Emerging themes were grouped into major and minor categories. The next section, Chapter four, details how the study results were presented and analyzed. Also, in this chapter, I have included a critical section on how this study contributes to social change and professional practice. Finally, clarifications and recommendations for future research are highlighted.

Chapter 4: Results

The purpose of this qualitative study was to understand the approaches nurses and their leaders have employed to ensure proper use and implementation of BCMA technology and its sustainability in acute clinical care units. To address this purpose, two primary research questions were asked:

Research Question 1: What are the nurses' perceptions of the use and optimization of system and patient outcomes?

Research Question 2: What approaches do clinical nurses and nursing leadership have in place to ensure that BCMA technology is appropriately used and sustained in the acute care units?

This chapter includes the demographic information of the participants. Details of the data collection are discussed, including information regarding how the data were gathered and recorded. A thorough description of the data analysis process is presented, followed by a description of the data's trustworthiness. Finally, I present the study results and conclude with a summary.

Demographics

A total of eight individuals agreed to participate in the study. All eight participants were either registered nurses working in an acute care medical center or nurse leaders in a managerial and education department with knowledge of BCMA. Nurse leaders at both managerial and executive levels were invited to participate. Although all participants were nurses, not all participants worked as a staff nurse or unit nurse. Other types of nurses including managers, supervisors, and employee development

personnel were included in the study, provided they had experience using BCMA technology. No executive level managers volunteered to participate. Participants had between 4 and 20 years of experience working as a nurse. Participants had an average of 11 years of experience. The median experience was 16 years. Most participants held bachelor's degrees (62.25%), two participants (25%) had master's degrees, and one (12.5%) had an associate's degree. Many participants worked as staff nurses, but two participants (25%) worked as managers or supervisors, and one (12.5%) worked in staff development. Table 1 presents the demographic information of the eight participants.

Table 1

Interviewed Participants' Education and Experience on BCMA Use

Code	Degree level	Years of experience	Position
RN1SN	Bachelor's	5	Staff nurse
RN2SN	Bachelor's	10	Staff nurse/super user
RN3SN	Associate's	15	Staff nurse
RN4NM	Master's	12	Nurse manager (leader)
RN5HS	Bachelor's	20	House supervisor (leader)
RN6SN	Bachelor's	9	Staff nurse
RN7SN	Bachelor's	4	Staff nurse
RN8SD	Master's	14	Staff development (leader)

Data Collection

To initiate data collection, I e-mailed 60 prospective participants a letter of invitation to take part in a face-to-face interview including six semistructured questions. The e-mail sent to potential participants explaining the importance and purpose of the research, a brief description of the study, the valuable nature of their contributions, and a

brief description of what was expected of them during the interview. Consent forms were e-mailed to the potential participants along with the invitation to participate. The consent form provided my assurance regarding their privacy, confidentiality, and the voluntary nature of their participation. The potential candidates were asked to reply to the e-mail affirming their agreement and intent to participate. Out of 60 invited individuals, 18 responded indicating their wish and intent to participate. Three persons replied with a regret while 39 invitations received no replies. Communications were initiated with all persons who professed a desire to participate. Nurses who chose not to participate came from different medical units within the hospital. As such, no determination that can be made as to why they chose not to participate. Also, nurse leaders at both managerial and executive levels were invited. However, only a few managerial level leaders agreed to participate, and no executive-level leaders chose to participate. One executive nurse leader offered to be interviewed over the phone citing time constraints. However, this interview was not conducted in this study.

Convenient dates, times, phone numbers, and other essential information to facilitate the interview process were exchanged between participants and myself. Fourteen interviews were scheduled with individuals who followed through with the interview preparation. Six participants did not show up to their scheduled interviews. The remaining eight participants were interviewed and agreed to answer all six questions.

Each interview took between 30 and 60 minutes and was conducted at a location convenient for the participant. The entire interview process was conducted over a period of 4 weeks. All participants consented to their interview being recorded by a handheld

audio recorder. Recordings of the sessions were transcribed to allow for accurate analysis of the data. To increase triangulation, I also collected supporting documents (see Fusch & Ness, 2015). Three memos and four policy documents closely related to health care information technology were obtained.

Data Analysis

The interview transcripts from the audio recordings were uploaded to NVivo 11, a qualitative data analysis program, to organize and analyze the data. Eight participants were interviewed, and when their taped interviews were transcribed, 17 pages of data were produced. Eight documents were examined, one for each participant interview. Each interview transcript was between one and three pages in length. I read through each transcript and kept the main research questions in mind to create an initial set of apriori codes. I then conducted a second reading of the transcripts, collating the initial apriori codes into new codes that arose from the data. These emergent codes became the bases for themes that emerged throughout the data analysis. On the third and final reading of the transcripts, emergent codes were further refined to eliminate unnecessary codes and clarify vague codes. Documents obtained from the institution were also reviewed with information transcribed.

Codes

All emergent codes were identified organically from the data, meaning that the codes were created as they appeared in the data (see Saldaña, 2015). Throughout the coding process, unnecessary codes were eliminated, or codes were further refined and defined (see Saldaña, 2015). The codes occurred prominently in the data, meaning they

were commonly coded throughout the participant interviews or were commonalities that were of importance to the research questions and purpose (see Saldaña, 2015). The following codes emerged from the data: system bugs, ease of use, hope for future development, and intragroup and self-monitoring. Other codes included information technology (IT) help, additional scanners, no previous tech experience, nurse input, old technology, overreliance on technology, paper backups, reduce cost, reduce error, time saving, and training for nurses. Table 2 presents the codes identified in the data analysis.

Table 2

Codes Used in the Study and Their Occurrence by Participant

Code name	Number of participants	Number of times coded
System bugs	8	18
Ease of use	5	7
Hope for future development	3	4
Intragroup and self-monitoring	4	5
IT help	4	7
Additional scanners	2	2
No previous tech experience	3	3
Nurse input	3	4
Old technology	3	4
Over-reliance on technology	3	3
Paper backups	4	4
Reduce cost	2	2
Reduce error	7	13
Time saving	3	4
Training for nurses	8	9

System bugs. The system bugs code referred to the participants reported instances of errors within the BCMA technology. Two issues were reported within this code: issues related to the program itself and those related to connectivity errors between the system

and the server. System bugs was a prominent code, as system bugs were discussed 18 times among all participants.

Ease of use. Participant statements declaring barcode medication administration technology easy to use were grouped into the ease of use code. Despite the prolific instances of system bugs, five participants reported that the system was easy to use. This code included statements regarding the handheld scanner used to scan patients' wristbands as well as the medication administration program. Every participant who declared that the system was easy to use also reported system bugs. This implied that the system was easy to use when it was functioning properly.

Hope for future development. Hope for future development included all comments regarding participants' curiosity and hope for future development of BCMA technology. These included statements about how the participants believed future versions of the scanner and program would be improved, and about similar technologies used by nurses. Three participants expressed hope for future technologies, indicating they believed BCMA technology would get easier to use and that they believed it would be an increasingly important tool in their work. These participants believed that technology, such as BCMA scanners, was becoming increasingly common in health care, and that these technologies allowed nurses to be more efficient while preventing errors. No participant indicated that BCMA scanners would become less relevant in the future.

Intragroup and self-monitoring. Intragroup and self-monitoring was a code that indicated how participants either monitored their behavior to ensure they used available BCMA technology to the fullest or how they worked to keep other nurses accountable.

Four participants reported that they used intragroup or self-monitoring to ensure the technology was used.

IT help. The IT help code included all statements discussing IT assistance and its relevance to BCMA technology. Four participants discussed IT help in the interviews. IT help included instances of needing IT assistance and suggestions regarding IT assistance.

Additional scanners. Additional scanners was a code with a low number of occurrences but with particular importance to the data. Two participants discussed how acquiring additional scanners would affect their work. Although this code did not commonly occur in the data, it included unique statements from two different participants. Both participants indicated that they believed that providing additional scanners for nurses was a more efficient way to address common system failings. These nurses reported that at any given time, about two of their scanners were nonfunctional out of the typical six on a unit. These nurses reported that rather than expecting there to be fewer nonfunctional scanners or expecting these scanners to be fixed quickly, it was more realistic to buy more scanners so that there would be enough scanners to go around, even when a significant number of them were nonfunctional.

No previous tech experience. Three nurses indicated that they had no previous experience using similar technologies before they began using BCMA technology. These statements were coded as “no previous tech experience.” Although all participants’ experiences with a lack of technological expertise were different, these narrations were grouped due to their similar relevance for the study. That is, the approaches that nurses use to properly implement and sustain BCMA technology in clinical care units.

Nurse input. When participants discussed how their contribution had affected their workplace's use of BCMA technology, or how they wished nurses' input would be solicited, those statements were coded as nurse input. Three participants discussed nurses' input. There was a discrepant case in this coding group, with one participant saying input was taken into consideration and others saying it was not. Analysis of the finding was weighted more heavily in favor of a lack of input, as the participant whose input was taken into consideration was a super user or a nurse who was chosen to help other nurses use BCMA technology. Although this response provided an interesting perspective, the participant's experiences regarding input were not representative of the user group. During early stages of BCMA rollout and implementation, the multidisciplinary working team was composed of hospital leaders, pharmacists, medical doctors, top nurse leaders, and vendors. Nurses were consulted when establishing super users, but not during actual planning.

Old technology. Old technology was a code that included discussion regarding how the participants' hospital used older versions of the BCMA technology or discussions involving how the technology they were using could be upgraded with a newer or more advanced model. Three participants discussed old technology as it relates to BCMA.

Overreliance on technology. Three participants discussed incidents in which they felt like they or their colleagues struggled to do their jobs when BCMA technology was nonfunctional. This code also included participants who stated that they or their colleagues had become overreliant on BCMA technology to the point that their

effectiveness was diminished when the BCMA was nonfunctional to the point where they were less effective than before the technology was implemented. This condition meant they were more likely to make errors.

Paper backups. Paper backups was a code that related to over-reliance on technology and system bugs. The paper backups code grouped statements indicating that paper BCMA forms were used when BCMA scanning technology was unavailable. This code included nurses' description of how paper backups could be used as well as suggestions that paper backups be kept available in such an event. Four participants discussed paper backups.

Reduce cost. Reduce cost was a code given to statements that indicated that BCMA technology saved either the hospital or the patient money. Two participants made this claim. There was also one discrepant case stating that the opposite was true. This participant indicated that BCMA technology was expensive to maintain. Given that this participant did not indicate if BCMA technology was more expensive than using paper BCMA forms or if it was merely that both methods were expensive, the data analysis was weighted more toward BCMA technology as cost saving.

Reduce error. Nearly all participants agreed that BCMA technology reduced error among the hospital and nursing staff. Seven participants indicated that this was the case. Statements discussing this benefit of BCMA technology were grouped into the "reduce error" code. This was one of the most prolific codes in the study. Data obtained from the hospital's quality improvement statistics showed that errors had decreased since the beginning of the use of the system. However, medication errors were far from being

eliminated and needed to be addressed.

Time saving. Four participants indicated that BCMA technology could be time-saving. These statements included incidences where the participant discussed time-saving alone and when participants stated that BCMA could be time-saving when appropriately used or when it was functional. Two participants indicated that time-saving was reliant on functionality, which was not guaranteed.

Training for nurses. All participants discussed the training they received regarding BCMA technology. When participants discussed this training, it was coded as “training for nurses.” While some participants indicated, they received little training these statements were still grouped in this code.

Evidence of Trustworthiness

As indicated in chapter three, trustworthiness, both regarding analysis validity and ethical data collection methods, was taken seriously in this study. The researcher strived to attain and pay close attention to concepts of evaluation quality when collecting, recording and analyzing the data. The result was findings that are credible, transferable, dependable and confirmable.

Credibility

This study presents findings based on the participants’ experiences and opinions that are not unduly colored by the researcher’s bias. Neutrality was achieved by careful adherence to correct coding procedures. Data was continually reexamined and dissected for the accuracy of analysis and correct presentation of participant’s intended contributions (Carlson, 2010). All themes presented in this study are supported by direct

participant quotes that were not edited or overly prompted. Participants all agreed to participate freely, without being pressured to do so or incentivized to participate. While the sample size was modest, it was in keeping with similar qualitative studies (Mason, 2010; Lincoln & Guba, 1986). Data saturation was reached in the sense that no new codes emerged during the final few interviews.

Transferability

While the outcomes from this study mainly represent the opinions of the study's participants, the findings do present a certain degree of transferability to other contexts and settings. A detailed record of participants' demographics and a thorough description of their experiences safeguarded the quality of transferability (Schwandt et al., 2007; Lincoln & Guba, 1986). Major codes were applied in the data analysis procedure, and data saturation achieved when no new information was noted (Creswell & Poth, 2017; Schwandt et al., 2007). The results from this study could be of importance when hospitals plan to adopt different technologies. In a broader sense, any organization adopting a new or similar technology could benefit from understanding how nurses experience and perceive the adoption of BCMA technology. Many new technologies may face the same hurdles that BCMA scanning technology did, such as a need for training among potential user and a process for reporting bugs in the system.

Dependability

Dependability can be achieved by showing that findings are consistent and that similar results would be found if a different study employing the same techniques, context, and methods were to be conducted (Miles & Huberman, 2013). Due to the

closeness between credibility and dependability, an investigator can demonstrate that a study is indeed dependable if credibility is established (Creswell & Poth, 2017). As mentioned above, this study is credible as it presents findings based on the participants' experiences and opinions that are not unduly colored by the researcher's biases.

Additionally, all themes presented in this study are supported by direct participant quotes that were not edited or overly prompted.

Confirmability

To assure the results of this study were confirmable, the researcher included a detailed description of the data analysis procedure, including the coding process, the codes used and the direct quotes from participants that portrayed developed themes (Cope, 2014). To ensure confirmability, researchers establish objectivity by accurately presenting data as provided by participants (Anderson, 2010). The researcher was mindful of personal biases, presented the participants' lived experiences accurately and precisely. Member checking, reflective, and field journals were kept and considered during data collection and analysis (Houghton, Casey, Shaw, & Murphy, 2013). Member checking was done in several ways: continuously keeping journal recordings of participant's responses, posing follow up questions during interviews, and sharing data and preliminary results with some participants (Houghton et al., 2013; Lincoln & Guba, 1986; Riege, 2003). The researcher also included the interview protocol in this study (Appendix C). This protocol includes the open-ended questions asked of participants at the time of interview. This tool makes this study entirely replicable and available for confirmation.

Study Results

The following sections include an analysis of the data obtained for this study. The results will be presented by themes grouped by relevant research question. Each theme will be supported by direct quotes from the participants to ensure confirmability (Cope, 2014).

RQ 1: Use and Optimization of System and Patient Outcomes

Research question one asks, what are the nurses' perceptions on the use and optimization of system and patient outcomes? While all participants had different views regarding the effectiveness of the use of BCMA technology, some common themes did emerge from the data. These themes included the perceived benefits of BCMA (coded as ease of use, reduce cost, reduce error, and time saving), barriers to effectiveness (coded as no previous tech experience, old technology and over-reliance on technology) and improving effectiveness (coded as paper backups, additional scanners and hope for future development).

Perceived Benefits of BCMA

All participants reported that they found value in BCMA technology. While BCMA technology was not without its flaws or areas that needed improvement, participants were quick to point out the benefits of using BCMA scanners and universally agreed that this technology was useful in its current state and was likely to become more helpful in the future. The perceived benefits of BCMA technology included how easy it was to use, its potential to reduce costs for the hospital and the patient, its effectiveness in reducing medication errors, and its time-saving potential for nurses.

Ease of use. Many participants reported that BCMA technology was easy to use. Five participants explicitly stated that BCMA was easy to use, and the remaining three participants did not express that the technology was hard to use, a determination was simply not made one way or the other. Respondents agreed that the BCMA scanners were both comfortable and convenient to use. RN5HS articulated this by saying, “The barcode medication administration is an electronic system used by the hospital to administer medication appropriately and efficiently. The system is very efficient and easy to use, therefore, acceptable to staff members.”

While participants nearly all agreed that the system was easy to use, some participants caveated their statements with prerequisites to the program’s ease of use. For instance, in the case of nurse leader RN5HS who work as a nursing supervisor, the system was considered easy to use as long as the individual was computer literate. RN5HS indicated this by saying, “It is easy to navigate and use the system. As long as a staff member is efficient using a computer, using the system is easy and user-friendly.” RN1SN echoed this sentiment. She indicated that she found the BCMA system easy to use because she was good with computers. This implies that one who was not well acquainted with technology may find the system harder to use. RN1SN indicated this by saying, “I did not find it complicated to use the medication scanners since I am generally good with computers.” While the scanners are not a computer, RN1SN was implying that she found the technology easy to use, but that she is also well acquainted with technology. She may be implying that someone who was not well acquainted with technology may not find the system so easy to use.

RN1SN also indicated that the BCMA system was easy to use effectively if the scanning was done properly. RN1SN stated, “When the scanning is properly done, it is easy to comply with the billing requirement.” This important distinction was one that was echoed throughout the interviews. Participants often indicated that BCMA technology was easy to use if it scanned properly, or that it could save them time in their jobs if it were connected properly with the server.

Cost saving. Two participants reported that BCMA technology could be cost saving. It was compelling to note that one participant indicated that BCMA technology saved the patient money while another participant indicated that it could save the hospital money in operation costs. It is entirely possible that both are true. RN4NM who is also a nurse manager stated that BCMA technology lowered the hospital’s operation cost by saying, “Yes, every day we strive for the best and we want to lead other health care centers in the metro in using any technology that can improve patients’ safety and perhaps lower the hospital operation cost.” RN4NM works as a nurse manager. By contrast, RN1SN, a staff nurse, indicated that BCMA could save the patient money by saying, “When the scanning is properly done, it is easy to comply with the billing requirement. Meaning the patients are only charged for what they actually use.”

It is logical that, as a nurse manager, RN4NM’s perspective would be more attuned to hospital operation than the treatment of individual patients. As a staff nurse, RN1SN would be more likely to know and understand how BCMA affects the treatment of individual patients. It is, therefore, possible that RN1SN and RN4NM see different aspects of BCMA’s cost-saving potential.

Error reducing. Seven participants indicated that BCMA technology helped reduce medication and other kinds of patient treatment errors. This benefit was as beneficial to the patient as it made treatment safer for them, the hospital, as it cut down on potentially litigious situations and for nurses individually, as they were less concerned about making a mistake. RN3SN indicated that since using the BCMA scanner made it harder to accidentally medicate a patient. She indicated this by saying,

The system alerts me on various issues such as allergies, right patient, frequency, and others. While no one is prone to making mistakes, I have reported very few mistakes than when I was depending on paper MAR. I would say it is manageable. It is a little harder to harm the patient when using these scanners.

RN3SN went on to say, that while she had always been accurate when treating patients, the scanner made it possible for her to remain accurate while spending less time ensuring that her treatments and medications were correct. This, in turn, allowed her to focus on other tasks. RN3SN indicated that,

I believe the system gives us nurses the opportunity to dwell on other things more than worrying about making mistakes when administering the medication to the patient. When devices are working, it is possible to access the medication record wherever I am without going back and forth to the desktop. A nurse can open the medication record by a mere scan of the patient's wrist.

Like RN3SN, RN4NM indicated that she had seen a decrease in medication errors since implementing BCMA technology. RN4NM indicated that, while there were pros and cons to BCMA technology, that was true of most new technologies, and that the

obvious benefit in patient safety was motivation to use BCMA scanners. RN4NM indicated that,

It is very convenient, easy to use and prevent medication errors. Of course, there are pros and cons of having this system. The obvious benefit is that we have seen a reduction in medication errors over the course of implementing this technology.

RN6SN reported that while she is not entirely convinced BCMA scanners are faster than using paper tracking systems, she is sure the scanners provide a benefit to the hospital. RN6SN indicated that BCMA scanners did reduce medication errors when they were used consistently. This shows that when nurses reliably use BCMA scanners, there are fewer medication errors made. RN6SN indicated this by saying,

Although bar code scanners have issues, it is safe to say that they help. I will admit that I was critical of whether it is easier to use papers or use scanners.

When they bring the scanning rate report, you can see not as many medication errors are noted as before.

RN6SN went on to say that she has heard that there is science-based evidence to confirm that BCMA scanners reduce medication mistakes and that her personal experience also supports this finding. RN6SN indicated that she made fewer errors since she started using BCMA technology by saying,

The evidence-based team told us that scanning of patient's armbands using medication scanners has actually lowered the medication errors. I tend to believe so because personally, I have not made many mistakes as I did before.

RN7SN agreed with RN6SN's assessment of BCMA scanners as error reducing. RN7SN stated that BCMA technology prevents mistakes by alerting the user if the patient and the medication are incompatible or don't match. RN7SN explained this benefit by saying,

I can say they are safe to use. Patients rarely get the wrong medications. Because the system is connected to the EMAR in the EPIC, you do not have to go back and document. When you scan the patient and medication, the record is automatically reflected in the computer. I like the fact that there is no shortcut. You have to scan the patient and the medication, and if there is no match, then the scanner will alert you.

Another nurse leader RN8SD who work in staff development indicated that BCMA technology's ability to reduce medication errors was a driving force behind its implementation in her hospital. A reduction of medication errors was the main feature of BCMA that compelled the hospital to utilize the system. RN8SD stated this in the following way,

I work closely with the education department and the unit managers, and I am aware of all projects that takes place in the patient care units. So, I know the medication scanning devices were introduced in line with hospitals goals of improving the patient care, particularly the medication safety. This technology was rolled out in different hospitals during early days of research and over time, it has been found to greatly reduce the medication errors. So, we are happy to have

barcode medication system in our hospital. I know it is not perfect, but we strive to reach the highest level of medication safety.

Time saving. A few participants reported that BCMA technology was time-saving, as it made patient information more readily assessable than it was before. One participant indicated that it also saved them time on medication administration. RN4NM indicated that this was the case by saying, “Some nurses report seeing some changes in the time it takes to complete the medication administration.” According to two other participants, information accessibility was a driving factor in BCMA’s time-saving ability. RN5HS indicated that, in addition to creating time-saving accessibility, BCMA technology had the added benefit of reducing the nurses’ workload. RN5HS expressed this by saying,

Patient information is easily accessible using the barcode on the wristband of the file. The BCMA introduction has actually reduced the workload and accessibility of the patient information making the process easy and reliable to the staff members.

Barriers to Effectiveness

While BCMA technology was seen as efficient and useful, there were reported barriers in its effectiveness. These obstacles made it difficult for participants to utilize BCMA technology to its fullest potential. Barriers to effectiveness, as reported by participants include system errors, no previous tech experience, old technology and over-reliance on technology.

System errors. Despite participant's enthusiasm for BCMA technology, all participants reported that they had encountered system errors when using the scanner or the accompanying program. These errors can easily lead to workarounds that could compromise patient safety. These errors included issues with the scanner, the program, or the program or scanner's ability to connect to the system server. RN2SN reported errors in the software by saying,

Mostly, it is not technical but the software part of it. The hand-held device, for example, does not connect well to the system. Sometimes there is no connection between the scanners and the electronic medical record. For example, when giving medications to a patient from his/her room, and I try to scan the medication, a message is generated from the scanner stating that there is no connection to the server. I can tell you that you cannot proceed further in such circumstances. You are only left with two options, either to give the patient medication without scanning or wait for the good connection. If a patient can walk, I can ask the patient to come to the nurses' station to get the medication without scanning. This practice does not promote safety and confidentiality.

Like RN2SN, RN3SN also experienced system errors when using BCMA technology. However, unlike RN2SN, RN3SN reported that the errors she experienced were more often network or the device. RN3SN also indicated that new and upgraded scanners do not eliminate these system errors. The new scanners simply have their own set of problems. RN3SN indicated that,

The issue comes when there are network issues or when the device themselves stop working. As I said, the system is a good thing to have because it helps sort out meds errors.... but when you report an issue to the pharmacy or IT staff, it can take some time before it is fixed. This makes the system useless. You cannot believe that some nurses are still making medication errors because the gadgets they gave us fails all the time. They introduce new hand-held devices after a while, but that too comes with its own issues.

No previous tech experience. Three participants reported that they had no previous experience using technology similar to BCMA scanners before the implementation of BCMA technology in this hospital. This unfamiliarity with technology made it so that these participants had less of a base of experience than other participants, and may have needed additional training or time to learn to use the BCMA scanners comfortably. This conjecture is supported by RN1SN's testimony that she found the BCMA scanners easy to use because they had previous experience using similar technologies, had this not been the case, RN1SN may not have found BCMA scanners as simple to use.

One of the participants who indicated that she had no previous tech experience was RN3SN. RN3SN indicated that she had to adjust to using the scanner, but that it got easier and easier to do so the most she practiced it. RN3SN indicated this by saying,

I had not used computers, medication scanners or Pyxis before when I got hired. I used papers generated by the pharmacy. At first, using the scanner was kind of

intimidating to me. But, as time went I learned to use it, it became easier and easier.

Like RN3SN, RN6SN reported that she was initially unsure of how to use the BCMA scanners or of their usefulness. However, as RN6SN saw the scanners in use, she saw that they were useful and essential tools within her hospital. RN6SN articulated this by saying,

When I came to the medical center, I did not know what it was all about since I thought it was just another scanning, you know, just like checking out items from a grocery store. But, I have found how important it is when it comes to care of the patient. I highly advocate this kind of technology to hospital and healthcare.

RN8SD also reported that using BCMA scanners was a new and novel experience. RN8SD also stated that there were several other nurses, like her, who began using BCMA scanners with no prior experience using similar technology. RN8SD explained this situation by saying,

I have been here for about 14 years, and this means that this technology found me here. I was a floor nurse back then, and all we did was paper charting and using medication record prepared by the pharmacy. This also means that I and other nurses had no prior knowledge of this system.

Old technology. A few participants reported that they felt that the BCMA scanners they were using were out of date, or that upgraded models of the scanners or the accompanying program were available. RN6SN indicated that while she wished more effective technology was available to her, she felt like new technology was often

introduced before the entire staff had time to learn the old technology. She expressed this by saying,

They were talking of replacing them with the newer one. They mentioned iPhone. I do not know whether we are going to create an app or something like that but will see when that happens. As I said, I wish we could have effective scanners so we can do our job, as they want us to do. Seems like they bring new technology even before people learn or enjoy the current one.

RN6SN went on to say that she did not understand why they would continue to use older versions of the BCMA scanners if newer, better models were available. This went along with her previous statement, in which she indicated that she wished the technology that was available to her and her colleagues could be more efficient.

These scanners are also bulky. If the cellphone technology is available, why not use it? My expectation would be that, for all of us to get the maximum benefit out of this technology the managers or maybe those who place orders or requisition for the scanners need to do some homework and bring the best and efficient scanners.

Like RN6SN, RN3SN believed that the scanners the hospital currently had available were bulky and cumbersome and that a newer, sleeker model was available and simply hadn't been purchased by the hospital. RN6SN described her experience using the scanner by saying,

The devices are too heavy, they are slow, and I believe a faster system is possible.

The ones we currently use are slow. They are saying another new model will be installed, but that has not happened yet.

From her testimony, RN4NM seemed to be discussing the same scanner upgrade that RN6SN and RN3SN had heard discussed. Like the other participants, RN4NM had heard that the newer models of the scanners were more effective than the models they were using and that the models resembled something similar to a smartphone. RN4NM indicated that,

Also, the devices we used in our units are getting old and replacing them with newer models might make the system friendlier to use. The possibilities of using apple like phones is floating around that might come to be the case.

Overreliance on technology. While participants universally appreciated BCMA technology, some participants indicated that the use of BCMA technology made nurses overly reliant on technology to do their jobs. When this technology was unavailable, this could create a problem for the hospital's effectiveness. RN5HS indicated that, because the staff had gotten used to using BCMA scanners, the other nurses became frustrated when they were required to do additional paperwork when the BCMA system was down. While many of these nurses had done the same paperwork before the implementation of BCMA technology, they had gotten used to the scanners, and when the scanners were nonfunctional, the paperwork became a greater chore than it had previously been. RN5HS indicated this by saying,

Staff have a tendency of over-relying on the system, and if this continues to be a hospital culture without stopping the practice, medication errors are usually inevitable. This is true when nurses start skipping the basic rights for medication administration when administering the medication to their patients. If the system goes down, the challenges of using downtime paperwork is irritating to staff due to the over-dependence on the system.

Like RN5HS, RN6SN noticed that, when the BCMA scanners were down, it became harder for individual members of staff to function, as they had gotten used to having the technology available. RN5HS indicated that, when the scanners were down, the pharmacy took longer to send a medication that had a barcode. RN5HS articulated this by saying, “Sometimes the medication barcode does not scan. When you call the pharmacy, they take too long to send the right medication that has a good barcode.”

Improving Effectiveness

Many participants spoke of ways in which BCMA technology could be improved to increase the effectiveness of the technology. Participants also spoke of “workarounds” they had created or discovered to do without BCMA scanners when the system was unavailable. These workarounds are demonstrations of how participants learned to cope with an imperfect system. Ways in which participants have improved the effectiveness of working with BCMA technology include paper backups, additional scanners, and hope for future development. One participant mentioned overriding of the system as a workaround. While this practice temporarily relieves nurses’ immediate frustrations of system failure, it is a drawback to maximizing and sustaining BCMA technology.

RN7SN reported the continuation of the practice of overriding the system to bypass the scanning of the medication or patient armband. RN7SN stated,

I have seen many nurses who continue to override the system despite the fact that we are highly discouraged to do that. I understand, sometimes they are frustrated when the system is not working, and they want to do their job.....

Paper backups. When the BCMA system was down, four nurses reported that they kept old-fashioned paperwork available to request the medication a patient needed. These paper backups meant that the nurse could quickly and efficiently recover should the BCMA system not work. RN2SN indicated that while going back and forth between paper and digital files was inefficient for everyone; it was important to have the paper backups to deliver medications to the patients in a timely manner. RN2SN indicated that,

When there is system breakdown or downtime since this happens occasionally, I make sure that the pharmacy has the paper MAR ready to assist nurses to safely administer medications. Again, this is not always done in a timely manner and can force nurses to use other ways to satisfy their patients. The problem with paper MARS is that it is difficult for every other caregiver to have the current medication administration record especially doctors who might need to change the orders and the nurse who want to know when the medication was previously given. So, going back and forth from paper to scanners is not pretty.

While paper files may be a backup practice for RN2SN, RN4NM indicated that some hospitals still use entire paper records instead of newer, digital systems. RN4NM

indicated that this practice was surprising, as a digital system is preferable. RN4NM indicated that,

This system consisting of handheld devices that are connected to the electronic medical record was introduced to this hospital not too long ago. But I can tell you we are ahead of others. Some places continue to use papers MARS. Surely all hospitals should make use of this system.

Additional scanners. Several participants indicated that at any given time, all the BCMA scanners were unlikely to function fully. While improving the functionality and reliability of the scanners was a priority for many participants, RN8SD indicated that an alternative workaround would be to simply get more scanners. With more scanners available, RN8SD hypothesized that it would be easier to find a working one, even if several of the scanners were currently nonfunctional. RN8SD indicated that,

The current number of working scanners in my unit are fewer than the number of nurses. This can be changed. I have asked about this. I hope they are considering it. Having more devices ensures that a broken device does not stall the work of a nurse or rather create a safety issue. I do remind the nurses, especially the new ones, to identify the devices that are not working so that the fixing can be done in a timely manner. A frustrated nurse can get silent while looking for other means to do his or her job. This is not good since it can threaten the patient safety. Safety and quality departments monitor the nurse's scanning rate and guess what, you will be surprised how many nurses do not get 100% as required by the institution.

There is no one person to blame here since it is a combined effort right from the top management to the person who is using this technology daily.

Like RN8SD, RN7SN indicated that increasing the number of scanners on a floor or in a unit would increase the likelihood that a working scanner would be easy to find when it was needed. RN7SN indicated that this workaround was one she had suggested before, but hadn't seen any action Taken on her suggestion. RN7SN said that,

I advocate for extra devices so that when one breaks, the nurse can use the other one without waiting too much. When a device is not working, I put a sticker, and I let the unit secretary know. That way she can quickly call the IT people to come fix it. During the unit meeting, I have asked the manager to have more working scanners brought to the unit to facilitate the care without much disruptions.

Hope for future development. Three participants indicated that they were optimistic and hopeful regarding the future of BCMA scanning technology. While these participants expressed that the technology currently had errors that needed to be addressed, they also indicated that they believed the technology was improving, or that it would be improving in the future. RN7SN expressed this by saying,

Yes, every RN who is administering medications is required to use a hand-held device to scan medication and the patient before actually giving it to the patient. Sometimes it works, sometimes it does not. I have used them before but the technology was very new to the market, and I did not like them at all. Now things are improving. Now things are improving.

RN2SN and RN8SD also indicated that they hoped the technology would keep improving, or that the main thing they hoped to see in the future as an improvement in the BCMA scanning technology that was available to them. This hopefulness indicates that while there may be errors in the currently BCMA technology, there is interest among participants in seeing the technology improve.

RQ2: Ensuring That Technology is Used and Sustained

Research question two asks, what approaches do clinical nurses and nursing leadership have in place to ensure that BCMA technology is used correctly and sustained in the acute care units? Participants expressed several different strategies for ensuring that BCMA technology was used and sustained in their workplace. Common themes relating to research question two include intragroup and self-monitoring, IT help, training for nurses, and nurse input.

Intragroup and self-monitoring. Self-monitoring or monitoring of their peers and colleagues was one of the ways that participants conveyed that they safeguarded the use of BCMA technology in their workplace. RN8SD reported that she and her colleagues often had to remind other nurses to use the BCMA scanners. Despite participants' overall positive view of BCMA technology, RN8SD indicated that some of her colleagues were resistant to using the technology. RN8SD indicated that,

Not everybody likes technology. So, we constantly remind the nurses of the importance of using the system. This is a big hospital system, and things do not happen as quickly as we would want them to happen

Like RN8SD, RN4NM indicated that she encourages her colleagues and those she supervises to use the BCMA scanners at every opportunity. Also, like RN8SD, RN4NM reported that not everyone consistently uses the scanners when they are available.

RN4NM indicated that,

As a manager, we encourage staff nurses to use these devices every time they are passing medications to the patient. Does this happen all the time? No. There are some cases where the use of this system is not hindered by the system failure but by nurses, who at times, like shortcuts. So, making everyone use it at all times is not always fruitful. For example, some older nurses who are generally slow in accepting the use of new technologies tend to cite their nursing experience as a reason for not needing any new technology to do their job.

RN4NM went on to say that they try to work with nurses to ensure that they have the tools they need to use the scanners effectively and efficiently. RN4NM's comments also indicate that there is a way to remotely monitor and an individuals' use of BCMA scanners. This monitoring system would provide additional assistance in ensuring use of the device. RN4NM indicated that,

We have emphasized the scanning rate. If a nurse gets a scanning rate of less than 90% in a specified quarter, that nurse is summoned and perhaps educated. We understand that it is not always that the nurse had all the tools he or she needs but it demands some explanations why some nurses will get 85 and others 95% that tells you there is a problem. During the institutional orientation and during the

unit orientation, the new staff are constantly reminded of the importance of scanning and patient safety.

IT help. IT help was seen as an essential component among participants in the reduction of system errors within the BCMA scanning system. Participants expressed concern over troubleshooting system errors without the assistance of IT personnel. RN1SN indicated that without IT personnel, troubleshooting the BCMA system would be difficult. RN1SN indicated that,

Frequent breaking up, developing connection issues. Sometimes I wonder whether it is the device or network problem. Sometimes the device does not connect well with the medication record and electronic medical record. When there is no available technician to take care of the broken scanners, the effort to reduce errors is crippled.

Like RN1SN, RN6SN saw readily available IT personnel as necessary to the continuing functionality of the scanners. She recommended having IT on call 24 hours a day to maximize efficiency. RN6SN said that,

Once I find the scanner is not working I report immediately. It is not always ASAP fix, but at least the issue gets reported for the sake of nurses working the next day. These scanners are not always effective and something needs to be done so that a long-lasting solution can be found. Also, if they can have 24 hours IT tech who can quickly resolve any issues with these scanners, I think that can be very helpful.

Training for nurses. While all participants reported that they had received some training to use the BCMA scanning and program, many participants also indicated that they wished that they had received more training, or that training was more readily available. Participants offered suggestions about how the training could be improved. For example, RN3SN indicated that she believed training would be more effective in a classroom setting rather than online. She also suggested paying nurses to go through training would make it more likely that they would spend a greater amount of time learning to use the technology. RN3SN stated that,

Training was given briefly at the time of orientation and up and until months when I completed my unit orientation that's when I was able to use the scanners effectively. I have not seen any training on paper or online, but surely who would take all the time to read stuff on the computer when you do not have enough time for the patient. ...I wish there are some training that is done in a class setting where there are no other interruptions and why not get paid as well?

Like RN3SN, RN4NM reported basic training to use the scanners when she was hired at the hospital. RN4NM reported she had previous experience using similar technology so that while she could figure out how to use the scanners, it took her a while to do so. RN4NM said that,

I had computer skills, before being trained to use barcode medication gadgets, but I had not used the system before. Either way, it was easy to integrate the computer skills with this technology. Basic was given upon hire. But that training though helpful, it was not sufficient. It took a while for me to get use to the scanners.

RN5HS reported that she had received more training than other participants. She indicated that she had gone through training prior to the system launch and that the hospital had set up “super users” to help new users get accustomed to the program while they were learning. RN5HS described the experience in the following way,

The hospital had every employee attend user training classes prior to the launching of the system. When the system went live the Hospital employed super users for two weeks to handle the stress and difficulties encountered during the “go live” period. The staff members had 24-hour access to the super users who acted like resource centers for the staff during patient care times.

However, despite her apparent satisfaction in the training she had received, RN5HS indicated that she believed more and continued training was essential for other nurses. She indicated that training should be made available to nurses whenever there is an update to the program. RN5HS said that,

I do advocate for continued upgrades and education of the staff because it is paramount in the proper and efficient running of the program. The main issue is that any upgrade needs some form of training that many nurses do not have or many times do not attend.

Three memos and four policy documents closely related to health care information technology were obtained. There were no available policies explicitly addressing the issues of barcode medication administration. One policy document was noted to use the term “barcode medication administration.” The document pointed out that it was a hospital expectation that staff administering medication use the barcode

scanners. All the documents were devoid of any explanation regarding methods and processes on how the administration of medication was to be carried out using these scanners. This finding was consistent with statements made by RN3SN. This deficiency could be regarded as external or system factor that could prevent proper using, maximizing, and sustaining the use of the BCMA.

Nurse input. A few participants indicated that they believed nurses should be given more input in shaping the technology they will use in their work. These participants also believed that nurses were currently not being asked for their input, even though they use the technology daily. Providing nurses an opportunity to give their input was strategy participants indicated that the use of the BCMA technology could be guaranteed and sustained. RN6SN said as much when she indicated that,

Maybe I should add that the management needs to involve the input of the nurses who constantly use these scanners. Involving nurses who use these scanners might be helpful because nurses will have a choice of the kind of scanners that should be bought and brought to the unit floor. Instead, hospital leaders, pharmacists, medical doctors, top nurse leaders and vendors make all the decisions.

Like RN6SN, RN7SN indicated that she wished that health care institutions involved nurses in the decision-making process regarding the technology they use. RN7SN explained that the BCMA scanners are not the only example of technology designed for nurses without much input from them. RN7SN stated that “Sometimes I wonder whether those companies that make these scanners involve nurses when

improving the technology. I, however, believe that the technology will slowly improve with time.”

Summary

The purpose of this qualitative study was to understand the kinds of approaches nurses and their leaders have employed to ensure proper use of implementing BCMA technology and its sustainability in acute clinical care units. To address this purpose, two main research questions guided this research study. Those questions were as follows:

RQ1. What are the nurses’ perceptions on the use and optimization of system and patient outcomes?

RQ2. What approaches do clinical nurses and nursing leadership have in place to ensure that BCMA technology is used correctly and sustained in the acute care units?

The data indicated that participants generally had a favorable view of BCMA technology. Benefits of this technology included its ease of use, its potential for reducing hospital and patient costs, increased accuracy delivering and assigning medications to patients and its efficiency in helping nurses save time. Despite the general benefits to using BCMA technology, there were some barriers to proper use of the technology. These barriers included a lack of previous tech experience, old technology that needed to be upgraded and a general over-reliance on the technology that made it difficult to perform job tasks when the scanners failed. Despite the presence of these barriers to ease implementation of BCMA technology, participants remained hopeful about the future of the scanner and affiliated program. To address the barriers indicated by participants,

participants suggested keeping additional scanners readily available as well as paper backups.

Participants indicated that they used a variety of different approaches to ensure that BCMA technology was used and sustained in their place of work. One of the most prominent techniques was intra- or self-monitoring of nurses. This technique involved nurses monitoring themselves, their colleagues, or supervisors following the rate of scanning their team was doing. Participants also suggested that IT personnel be available 24 hours a day to assist with maintenance and that the input of nurses be taken into consideration when new technology was being developed.

This concludes Chapter Four: Findings. The following chapter, Chapter Five: Discussion, will further deliberate the results of the data discussed in this chapter. Chapter Five will discuss the researcher's interpretations of the findings, as well as other matters such as limitations of the study, recommendations for future research and implications of the study, recommendations for future research and the implications of the research.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this study was to explore the approaches that hospital nurses and leadership used in the successful implementation and sustainability of BCMA technology in acute clinical care units. I used the technology acceptance model TAM as a conceptual framework (see Davis, 1989). TAM is a frequently used framework, and the concepts of perceived usefulness (PU), perceived ease of use (PEOU), attitude toward use, behavioral intention to use, and actual use aligned with the problem of optimal utilization and sustainability of BCMA technology. TAM is regarded as a broad but well-established technology model (Gagnon et al., 2014; Tsai, 2014). Cheung and Vogel (2013) pointed out that TAM is one of the best models applied in both IT systems and methodologies that are being used to clarify technological systems. Several researchers validated TAM's effectiveness in understanding the role of human behavior in implementing and sustaining information technology (Lin et al., 2011; Rauniar et al., 2014). The key constructs of TAM can be used to predict success or failure of an implementation within any given setting (Holden & Karsh, 2010). TAM provided a lens through which the different strategies used by hospital leadership could be investigated. The participants consisted of five staff nurses, a nurse manager, a house supervisor, and a staff development representative. All participants were either current users of BCMA technology or had used the system before.

Interpretation of the Findings

Research Question 1

The first research question related to nurses' perceptions of the effective use and optimization of the BCMA technology and patient outcomes. All participants had different views regarding the effectiveness of using BCMA technology. I classified ease of use, reduced cost, reduced error, and time savings as codes that the participants perceived as benefits of using the BCMA technology.

Five participants referred to the ease of use as a benefit of BCMA technology when the system is in good working condition. The remaining three participants did not comment on the ease of use of the technology. Based on the responses, I concluded that the participants perceived the BCMA technology as easy to use. According to the literature and TAM, users' PU and PEOU may influence their intentions and attitudes with regard to system use (Davis, 1989; Khan & Woosley, 2011; Wallace & Sheetz, 2014).

Only two participants referred to reduced cost as a benefit. I concluded that participants viewed a reduction in hospital and patient cost as a possible benefit of using the BCMA technology. Three participants referred to error reduction resulting in increased accuracy in delivering and assigning medications to patients and its efficiency in helping nurses to save time as a benefit, as it made patient information more readily accessible than it was before the implementation of the technology. The benefit of reduced errors was referred to by seven participants. The reduction of errors may be beneficial to patients as it makes treatment safer for them (Lee et al., 2015). In addition,

the hospital may avoid potentially litigious situations, and nurses may be less concerned about making a mistake. Reduced cost, reduced error, and time saving could be classified as the user's view of usefulness. Based on the responses, I concluded that the users perceived BCMA technology to be useful when the system is in good working condition.

I classified system errors, no previous technical experience, old technology, and overreliance on technology as thematic codes that participants perceived as barriers to effectiveness. All eight participants referred to system errors as a problem in using BCMA technology effectively. System errors were identified as the most prominent thematic code in communication. System errors included issues with the scanner, the program, or the program or scanner's ability to connect to the system server. Nurses often believe technology will alleviate a set of problems, but it almost always brings its own set of problems, which can undermine the overall system effectiveness. Based on participant responses, I concluded that participants had negative experiences with regard to the ease of use and usefulness of BCMA technology. According to the research and the TAM, this may have created attitudes and behavioral intentions with regard to using the system (see Lin et al., 2011; Tsai, 2014; Wallace & Sheetz, 2014). Several participants referred to a lack of previous technical experience, old technology (i.e., scanners that needed to be upgraded), and a general overreliance on technology that made it difficult to perform tasks when the scanners failed. These responses were further evidence of attitudes and intentions that may have been created with regard to the use of the system. The notion of bringing in new technology before the previous one was learned could have been a theme, but the comments did not feature prominently in this study. Only one participant

offered a comment related to this notion. A lack of previous technical experience and continuous training was an indication of a lack of training in using BCMA technology. This factor may have created further negative attitudes and behavioral intentions to use the technological system (see Ajami & Bagheri-Tadi, 2013).

I classified paper backups, additional scanners, and hope for future development as thematic codes that the participants perceived as improving effectiveness. Only three participants reported having hope for future development. To ensure improved effectiveness, participants suggested keeping additional scanners readily available as well as paper backups. Several participants reported frustration with regard to the availability of scanners that were in working order and paper backups that needed to be used when the system was down. According to the TAM, these perceptions may have impacted the user's PU and PEOU (see Ajami & Bagheri-Tadi, 2013; Khan & Woosley, 2011).

Data analysis indicated acceptance by the end user as the primary concern in implementing technology (see Abdekhoda et al., 2014). The results of the study indicated that many barriers that affect the use of the technology present concerns with the approval of the technology by users. After implementation of technology, the users developed an intent to either use or not use the technology based on their belief that the technology would support them in performing their job. According to the TAM, the user's behavioral intent and attitude is determined by the user's PU of the technology together with the user's PEOU of the technology (Khan & Woosley, 2011). The results of the study indicated that participants' appreciation of the benefits and usefulness of the concept were influenced by problems experienced in the daily use of the system. A

positive behavioral intention meant that the user would use the technology as intended while a negative behavioral intention meant that the user would not use the technology as intended. According to the TAM, the perceived ease of use and usefulness determines the end user's attitude, which in turn, dictates behavior (Lin et al., 2011). Both the user's PU and PEOU could be influenced by external variables including contextual variables, system design features, and organizational management (Camisón & Villar-López, 2014; Kimberly & Evanisko, 1981). The results of the study highlighted variables like system errors and design, old technology, no previous technological experience, and various organizational management aspects as barriers to the effective use of the technology.

Research Question 2

The second research question related to the approaches that clinical nurses and nursing leadership have in place to ensure that the BCMA technology is properly used and sustained in acute care units. Participants indicated that they used a variety of approaches to ensure that BCMA technology was used and sustained in their workplace. Four participants referred to the self-monitoring of nurses as a prominent technique used to sustain the use of BCMA technology. This technique involved nurses monitoring themselves, their colleagues, or supervisors by monitoring the rate of scanning performed by their team. Hospital leadership encouraged nurses to use the technology at all times. Low scanning rates led to nurses being sanctioned and educated in some cases. These actions indicated that hospital leadership recognized the usefulness of the technology when optimally used, and expected nurses to use the technology at all times. The fact that system use needed to be monitored and that actions had to be taken meant that nurses

either experienced technical problems while using the system, were not adequately trained, or had negative perceptions regarding the usefulness and ease of use of the system.

Four participants suggested that IT personnel should be available 24 hours a day to assist with maintenance. The nonavailability of the system due to problems experienced, as well as the lack of IT support in these cases, was highlighted by most participants as frustrating. Participants displayed a concern with regard to troubleshooting system problems when system errors occurred in the absence of IT support. The frequency of system errors and the fact that system errors could, in many cases, not be resolved was frustrating and may have impacted the user's PU and PEOU. This frustration may have led to resistance to the use of the BCMA technology and other negative attitudes and intentions, such as interfering with the system and the proliferation of workaround strategies. These actions were not caused by the system only but also by the pressure mounted by external factors like the unavailability of support when required.

Factors such as technology placement, adequate training, communication, preparation, usability, and nurses' workflow are important factors to achieve maximum benefit and sustainability of BCMA technology (Wang, 2015; Wang et al., 2014b). Three participants suggested that the input of nurses be taken into consideration when new technology is being developed. These suggestions indicated that nurses perceived that their input with regard to design and use was not solicited despite the fact that they use the system daily. This perception could create negative attitudes and behaviors.

Participants reported that nurse input could assist in the formulation of future strategies and approaches to ensure sustainable use of the system.

Training for nurses in the BCMA technology, which was referred to by all participants, was identified as a problem in preventing them from using the system effectively. Although all participants reported that they had received some training in using the BCMA scanning and program, many participants indicated that they wished that they had received more training or that training would have been more readily available. Participants offered suggestions about how training could be improved. Lack of training may influence a user's PU and PEOU and create negative attitudes and behavioral patterns toward the efficient use of the technology (Khan & Woosley, 2011). Although one of the policy documents encouraged BCMA users to use the system, it did not specifically address how it should be done. All other documents lacked explanation regarding how the administration of medications was to be carried out using these scanners. This finding was consistent with interview findings indicating that nurses were not getting adequate and frequent training. There were no documented training sessions or evidence of frequent training on system updates. This deficiency could be regarded as an external or system factor (see Kimberly & Evanisko, 1981). External factors could prevent users from using, maximizing, and sustaining the use of BCMA (Camisón & Villar-López, 2014).

Problems with the effective use of BCMA technology could be expected in cases where hospital leadership fails to implement approaches and strategies to ensure effective and ongoing use and sustainability. Due to the design of the study, the results could not

verify whether the approaches and strategies identified by participants were adequate to ensure effective and ongoing use and sustainability of the technology. Increased level of nurse education and training, adherence to medication administration procedures, and reduced nurse workload have been cited as strategies that could reduce medication administration errors (Brandy, Malone, & Fleming, 2009; Wang et al., 2014).

Previous studies that have included the TAM indicated that technology can not be used and sustained when users experience problems with the usefulness and ease of use of the technology (Holden & Karsh, 2010; Khan & Woosley, 2011). Khan and Woosely (2011) indicated that after a project or technology is implemented in a health care setting, individual users develop intent to use or not to use depending on the belief that the technology will support them to accomplish their job performance. The results of this study confirmed that users tend to underutilize technology when problems are experienced, as evidenced by hospital leadership having to monitor the use of the system and take action when scanning rates decreased.

A beneficial effect is created when technology improves performance of a task without a significant increase in energy required (Davis, 1989). Wallace and Sheetz (2014) highlighted that users would be more likely to embrace technology or related behavior with a subsequent decrease in the suboptimization of that technology. The participants of this study referred to many technological and logistical problems as well as a lack of training and the ignoring of their input, which complicated rather than improved their task performance.

Khan and Woosely (2011) found that a technological system that is useful and easy to use is more likely to be accepted and adopted by users. According to the TAM, perceived ease of use and usefulness determines the end users' attitude, which in turn dictates the behavior (Lin et al., 2011). Behavioral intention to use or not to use could result in technology use or lack of use (Tsai, 2014; Wallace & Sheetz, 2014). Although participants understood the benefits and usefulness of the system, the problems experienced impacted their attitudes and behaviors with regard to the effective use of the system.

The PU and PEOU may be influenced by a cluster of external variables (Venkatesh & Davis, 1996). These variables may include variables of a technological, systematic, as well as a managerial nature, that may cause frustrations which may impact directly on the PU and PEOU of users. These factors include contextual variables, system design features, and organizational management (Camisón & Villar-López, 2014; Kimberly & Evanisko, 1981). The results of this study underlined the impact of external variables like system design features which was not in accordance with their inputs as well as organizational management aspects like a lack of training, and various logistical shortcomings like additional scanners and paper back-ups. Hospital leadership must take responsibility to effect changes in the perceptions that the participants reported with regards to using the BCMA technology. Firstly, leadership must ensure that system errors are minimized and that all logistical shortcomings like paper back-ups and additional scanners are addressed and managed. Secondly, leadership must ensure that IT support is

available at all times, that nurse's input is respected, accommodated and implemented where feasible and that training is supplied at the time and format required.

Limitations of the Study

A case study, as in various qualitative studies, is small scale and questions regarding validity and reliability usually arise when it comes to the integrity and credibility of results (Anderson, 2010). The low level of participation as well as the fact that the study was performed at one hospital only, limits the generalizability as well as the level of confidence, meaning that the results cannot be applied at any other hospital with confidence. However, in this study, data saturation was achieved since there were no new emerging themes at the end of the interview process. Subsequently, this means that a larger sample size at the same hospital or a similar study at another hospital might produce similar results. As such, replicating this research using the semi-structured interview questions designed for this study might discover different perspectives which would require additional research to determine the source of the differences.

According to this study, it may be assumed that users would utilize a system when their needs with regards to usefulness and ease of use are satisfied. It would have been interesting to verify whether nurses in this case study utilizes the BCMA technology optimally and whether lack of utilization would cause a decrease in the number of patients dying due to medication errors. However, this verification was outside the scope of this study. Although the design of this study did not provide for the investigation of possible workaround tactics, some evidence of workaround strategies among nurses were identified. Consisted with previous studies, nurses, at times, find shortcuts and bypass the

organization systems that are perceived to hinder their daily work practice (Cifuentes et al., 2015; Debono et al., 2013; Yang & Grissinger, 2013).

Unlike in quantitative research, maintaining, evaluating, and proving rigor in qualitative research is more difficult (Morrow, 2005). As discussed in Chapter three, credibility can be enhanced using a number of strategies including: (1) following all the necessary and acceptable steps in the research protocol (Noble & Smith, 2015), (2) presenting participants' opinions rather than researcher's understanding of the subject (Vivar, et al, 2007), and (3) allowing respondents to review data transcripts and preliminary results and then report back their feedback regarding interpretation (Anderson, 2010; Varpio, et al, 2017). Morse (2015a) recommended interviews with experts in the subject matter, especially when open-ended questions are used as a guide to generate information. The participation of subject matter experts added credibility to the findings resulting in a more balanced and specialized perspective on the utilization of the technology. Expectations in this study were met. The selected participants generated rich, and thick data as recommended by Morse (2015a). Interview questions were used as a guide to prompt information from interview respondents (Jamshed, 2014). Although the initial set of questions were not changed, they were paraphrased on some occasions based on what the researcher found from informants and experts to generate the needed information (Jacob & Furgerson, 2012). To test the validity of the data collection tool, the researcher carried out field testing of the developed qualitative research interview questions (Turner III, 2010; Van Teijlingen & Hundley, 2002). Testing was done with

subject matter experts composed of three coworkers practicing nursing in the acute care setting.

Generating data in that way may have led to over and under reporting.

Participants may have been hesitant to reveal their real perceptions due to a fear of being identified as having problems with the technology. Interview questions guided to the interview (see Jamshed, 2014). Although interview questions may be required to provide structure to the process, they may also limit participants in sharing relevant information. Hence, the initial set of questions can be changed based on what the researcher found from informants and experts (Jacob & Furgerson, 2012). These experts offered information that improved and refined the interview guide. As mentioned in Chapter 2, and Chapter 3, field testing process minimized the possibilities of bias, repetitiveness, and ambiguity (Turner III, 2010; Van Teijlingen & Hundley, 2002).

Recommendations

Research should be performed to establish benchmarks and measurement criteria that could be used to measure and classify BCMA technology implementations. The proposed research should address the technical BCMA system architecture, workflow, physical layouts and methods involved. BCMA implementation is a complex project that involves many disciplines, each with unique workflow challenges and implications. Nurses, for instance, have hardware reliability and interface configuration concerns, while pharmacists consider inventory management and efficiency maximization as essential. Stock accuracy, the time between the issuing of medication and the application of medication to the patient, stock shortages, stock returns, discrepancies and stocktaking

procedures are aspects that could form part of the proposed benchmarks. Benchmarks and measurement criteria can be used as roadmaps to assist hospital leadership teams and implementation project teams during future implementations. A closer look at the existing institutional policies revealed the existence of external or system factors that could negatively affect implementation of BCMA system. Organization leadership could develop educational materials and institutional policies that specifically addresses the BCMA system. This approach could ensure that nurses utilize the maximum benefit of BCMA by continually referring to the policies and upto date training of the system.

Due to the many behavioral, practical workflow and method changes required for a successful BCMA technology implementation, a positive user organizational culture that cultivates a willingness to change is required for successful BCMA technology implementation. Changes required for the successful implementation and utilization of the BCMA technology are extensive which emphasizes the importance of the right training and preparation. The proposed research should include one or combination of the following, (1) The aspect of project and change management and how resistance to change could be managed effectively to prevent unsuccessful implementations and workarounds, (2) The effectiveness and frequency of training courses for staff and hospital leadership to assist them in utilizing the BCMA technology optimally, (3) Focus on the relationship between the content and the frequency of the courses attended and the success of BCMA implementation and utilization, (4) Research could be performed as a quantitative study by quantifying the adherence to prescribed measurement criteria.

Research should be performed to determine the extent of and the reasons for the use of BCMA workaround strategies by nurses. Ideally, this research should be performed at several hospitals. The study design should be of an investigative nature as the results for each case may differ. It might entail the studying of work processes and methods used by nurses, the interviewing of nurses and hospital leaders, participating in the relevant BCMA meetings, performing cause-and-effect and workflow analyses, as well as BCMA data analyze. The objective of the proposed research should be to identify the gap between nurses' requirements and the practical experience of using and the ease of use of the BCMA technology. The results of the proposed research may be used by BCMA system developers and implementation project teams to ensure that the technology is error free, practical and that user needs are met in all cases while training is performed as required.

Implications

Findings from this research may add to the body of nursing knowledge about Health Information Technology (HIT) but also function as a tool for the evaluation of the effective utilization of BCMA technology. Another aspect of the significance of this topic regards the economics behind the BCMA technology that may highlight the need for changes in policies regarding business partners, future technology, employee training, and shareholders (Jones et al., 2014). Medication errors can result from staff nurses not utilizing the BCMA technology appropriately or due to sustained nursing workarounds (Debono et al., 2013). For this reason, optimization of BCMA technology and sustaining its use by nurses would ultimately decrease medication errors, hence, increase patient

satisfaction and a culture of safety. The insights gained from this study could also make clear to the hospital leaders and HIT project managers to apply only those necessary strategies that could achieve BCMA technology sustained utilization. The feedback from the nurses, as the end users of the BCMA technology, could also bring about technology redesign and improvement making it more efficiently aligned with the work that nurses do. Concerning the patient outcomes, McCullough, Parente, and Town (2016) agreed that any HIT that is meant to bring efficiency, accountability and safety could ultimately result in a positive patient outcome. Some of the notable outcomes demonstrating positive social change include improved cross-specialty care, lower cost of care, and reduced death rate, among others.

Understanding the use and sustainability of the BCMA technology may promote social change by reducing medication errors and the overall cost of medical expenses among community members around these healthcare centers. Similarly, reduction in errors might translate into a reduction in morbidity and mortality related to those medication errors. As a result, members of the community may tend to prefer healthcare centers that implemented the BCMA technology. Consequently, those health centers that have not adopted the BCMA technology might start considering the possibilities of implementing it to prevent medication errors which are expensive in terms of cost, prolonged hospitalization, and death among other risks (Samp et al., 2014). If healthcare centers have a good understanding of the short and long-term effects of these errors, they will be able to justify why the BCMA technology is necessary for reducing cost, risk, and inefficiency associated with these mistakes. These implications were consistent with the

scope of this study with the subsequent positive social change particularly low cost of healthcare with communities.

The results of the study confirmed that TAM as a conceptual model might be used as a framework to predict and determine whether HIT systems and the BCMA technology would be effectively implemented and sustained in a healthcare setting. The results of RQ 1 enabled the researcher to identify the external variables that impacted on the user's perceived usefulness (PU) and Perceived Ease of Use (PEOU) in accordance with the TAM constructs. Due to the design of the study, the results could not be used to predict or determine whether the BCMA technology was effectively utilized, as the results were based on perceptions only. A mixed method design may have produced results that could have been used to more accurately predict the outcome in accordance with the TAM constructs. The results of RQ 2 underlined the fact that strategies and approaches had to be implemented by hospital leadership to sustain the utilization of the technology. The need for these strategies and approaches was caused by the external variables which impacted on the PU and PEOU of the user's. According to TAM, the PU and PEOU of users would impact on users attitudes and behavioral patterns while deciding whether they would use the technology or not. The results of the study confirmed that the BCMA technology was used to a certain extent. The extent to which it was utilized efficiently could not, however, be determined or predicted due to the design of the study.

Conclusion

The purpose of this qualitative study was to investigate the strategies and approaches employed by nurses and their leaders to ensure successful implementation and optimal utilization of the BCMA technology. The research indicated that users tend not to utilize technology if they experience problems with the ease of use and usefulness of the technology which may imply some type of workaround strategy that could subsequently lead to the sub-optimization of the BCMA technology undermining its success and sustainability. The case study found that although many problems were experienced, some strategies and approaches were formulated to sustain the utilization of the BCMA technology.

The results of the study identified system errors as the thematic code most discussed by participants. All eight participants referred to system errors as a problem in efficiently utilizing the BCMA technology. All eight participants identified lack of training as a barrier to effectiveness. Seven of the eight participants mentioned that BCMA technology would contribute to a reduction in medication errors. Many of the participants recommended solutions like paper backups, additional scanners, and the availability of IT help 24 hours daily as solutions to the problems experienced. The results of the study indicated intra-group and self-monitoring as an important approach used by hospital leadership while all participants referred to training for nurses and nurse input as essential for success. Based on the results, it can be concluded that participants experienced problems with the ease of use and usefulness of the BCMA technology that

may create attitudes and behavioral intentions that were not conducive to the effective use of the technology.

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Appendix A: Letter of Cooperation

DocuSign Envelope ID: 3E3AA7C6-E3B1-4324-9545-653C81C01A65




Dallas, TX 75390

Date:

Letter of Cooperation

Dear Jackson N Njeru,

Based on my review of your research proposal, I give permission for you to conduct the study entitled "**Nursing Approaches for the Use and Sustainability of Barcode Medication Administration**" within the  **Medical Center Dallas facility**. As part of this study, I give you permission to conduct a face-to-face interview using your semi-structured interview questions' guide with a self-selected sample of 6 to 15 clinical team members comprising of nurses. You are also permitted to analyze, and disseminate results for educational purposes. Individuals' participation will be voluntary and at their own discretion.

We understand that our organization's responsibilities include: allowing access to the policies and internal memos related to the use of Bar Code Medication Administration technology system (BCMA). We also allow you to contact your potential respondents willing to participate using the organization's web email.

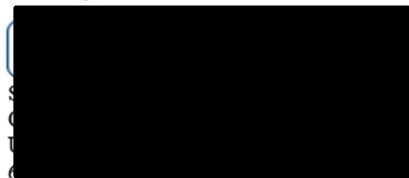
You understand that this authorization **does not include the use of computers or any other means to access, contact or review any patient or their medical records**. The institution reserve the right to withdraw from the study at any time if our circumstances change.

You will be responsible for complying with our site's research policies and requirements, including maintenance of privacy and anonymity of all research participants, HIPAA laws, and all other policies related to conducting research.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University IRB.

Sincerely,



Center

Dallas, Texas 75390

(P) 214-633-4803

Appendix B: Data Use Agreement

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DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of 2/10/2017 is entered into by and between Data Recipient **Jackson Njeru** and Data Provider [REDACTED]

[REDACTED] The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS"), memos, policies and procedures (if available) regarding Barcode medication administration technological system for use in research in accord with the HIPAA and FERPA Regulations.

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the "HIPAA Regulations" codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.
2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations

Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** The researcher will also not name the organization in the doctoral project report that is published in Proquest. In preparing the LDS, Data Provider or shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research: Copy of current **MEMOS and copy of the policy and procedure** relating to Barcode Medication Administration.

3. Responsibilities of Data Recipient. Data Recipient agrees to:
 - a. Use or disclose the LDS only as permitted by this Agreement or as required by law;
 - b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;
 - c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;
 - d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and
 - e. Not use the information in the LDS to identify or contact the individuals who are data subjects.
4. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for its research activities only.

Appendix B: Data Use Agreement (continued)

DocuSign Envelope ID: 75F53B43-6C6F-4120-AB53-7DE83231CC79

5. Term and Termination.

- a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.
- b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.
- c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.
- d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.
- e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

6. Miscellaneous.

- a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.
- b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.
- c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.
- d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

Appendix B: Data Use Agreement (continued)

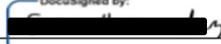

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- e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER

DATA RECIPIENT

Signed:  _____
DocuSigned by:
2D1549AE796247F...
Print Name:  _____
Print Title: 2/27/2017 | 7:34 AM CST

Signed: Jackson Njeru _____
Print Name: Jackson Njeru _____
Print Title: Walden Ph.D. Student

Appendix C: Research Question Guide

Topic: Nursing Approaches for the Use and Sustainability of Barcode Medication

Administration

Date: _____ Time: _____

Interviewer: Jackson Njeru

Location: _____

Participant (Interviewee Number): RN Number _____

Informed Consent signed? _____ **Yes/No**

Notes to interviewee:

1. Appreciation for time and participation.
2. Benefits and purpose of the study -nursing profession
3. Assuring Confidentiality of participant's responses
4. This interview last about 30-60 minutes answering six major questions

Semi-Structured Question Tool

The participants respond to the questions listed below.

Q1. Tell me about what you know or understand about the bar code medication administration technology system practiced in your healthcare setting.

- Your views
- Opinions
- Perception

Response

Q2. How were you prepared to use the BCMA technology system and what kind of education and training did you have since the beginning to use this technology?

- Your skill in using the technology
- Training offered before and after
- Resources available

Response

Q3. What do you think are some of the benefits and shortcomings of using this technology?

- Benefits
- Shortcomings

- Workaround

Response

Appendix C: Research Question Guide (continued)

Q4 What challenges do you face when using this technology?

- Concerns or issues have you experienced

Response

Q5. What are you doing currently or have done in the past to ensure that the use of BCMA system is successful in achieving your goals now and in the future.

- Strategies
- Are they effective, working – why or why not?
- How can it be maximized?

Response

Q6. Do you have any other information that you would like to share regarding BCMA system use in your clinical care area?

Response

Reflection by Interviewer

- Conclusion
 - Thank the respondent
 - Reassure privacy & confidentiality
 - Permission to follow-up

Yes/No_____

Appendix D: Permission Granted by Fred Davis to use TAM

Fw: TAM-JACKSON

Page 1 of 1

Fw: TAM-JACKSON

Mark as unread



Jackson Njeru

Wed 1/25/2017 7:25 PM

To: jackson.njeru@waldenu.edu;

Jackson Njeru MSN RN
UTSW Psychiatry
Zale-Fourth Floor

From: Davis, Fred <fred.davis@ttu.edu>
Sent: Monday, January 23, 2017 11:06 AM
To: Jackson Njeru
Subject: RE: TAM-JACKSON

Jackson

You have my permission to use TAM for your research. I don't believe you need any other authorization to use it.
Best wishes
Fred Davis

rom: Jackson Njeru [Jackson.Njeru@UTSouthwestern.edu]
Sent: Sunday, January 22, 2017 2:46 AM
To: Davis, Fred
Cc: jackson.njeru@waldenu.edu
Subject: TAM-JACKSON

Hello Professor Davis. My names are Jackson Njeru and I am working with the university of Texas southwestern medical Dallas. Currently am a Ph.D. student at Walden University. I am writing a proposal towards my nursing dissertation and I propose using Technology acceptance Model Proposed by you. I did not know who to ask, but I looked for your email. My question is, while using the TAM model for class purposes, do I need an official authorization to use it? If yes how do I go about it?

Jackson Njeru MSN RN
UTSW Psychiatry
Zale-Fourth Floor
Cell 2144917440

01/25/2017

<https://mail.waldenu.edu/>