The Relationship Between Barcode Medication Administration Satisfaction and the Use of Workarounds Among Registered Nurses

Sally Bennett

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THE RELATIONSHIP BETWEEN BARCODE MEDICATION ADMINISTRATION SATISFACTION AND THE USE OF WORKAROUNDS AMONG REGISTERED NURSES

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In partial fulfillment of the requirements for the degree of Doctor of Philosophy

By

Sally F. Bennett

August 2012
THE RELATIONSHIP BETWEEN BARCODE MEDICATION
ADMINISTRATION SATISFACTION AND THE USE OF WORKAROUNDS
AMONG REGISTERED NURSES

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ABSTRACT

THE RELATIONSHIP BETWEEN BARCODE MEDICATION ADMINISTRATION SATISFACTION AND THE USE OF WORKAROUNDS AMONG REGISTERED NURSES

By
Sally F. Bennett
August 2012

Dissertation supervised by Joan Such Lockhart, PhD, RN, CORLN, AOCN®, CNE, FAAN

Adverse drug events, resulting in preventable patient harm or death, are of great concern. To keep patients safe, hospitals have implemented barcode medication administration (BCMA) technology for RNs who have accepted this technology with varying levels of satisfaction. When nurses are dissatisfied with a BCMA system, they may find alternative methods to complete their work. Framed by the Technology Acceptance Model (Davis, 1989), this analytic, cross-sectional study aimed to understand the relationship between BCMA satisfaction and workarounds, perceived ease of use (PEOU) and perceived usefulness (PU) of a BCMA system by 80 hospital-based RNs in northeastern US. Data were collected using the Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN), which was adapted from Hurley’s (2006) Medication Administration System-Nurses Assessment of Satisfaction Scale (MAS-NAS) Halbesleben and Rathert’s (2010) Workaround Assessment. Results suggested that RNs who were more satisfied with the BCMA system were less likely to use workarounds.
than nurses who were less satisfied ($r^2(78) = -0.681, p < .05$). Significant relationships were noted among BCMA Satisfaction and PEOU ($r^2(78) = -0.725, p < .05$), Workaround Usage and PEOU ($r^2(78) = 0.943, p < .05$) and Workaround Usage and PU ($r^2(78) = 0.501, p < .05$). RNs perceived the BCMA system to be easy to use (PEOU), but not very useful (PU). BCMA Satisfaction was significantly related to the use of six workarounds, while Workaround Usage was significantly related to five. Significant relationships were also noted among both BCMA Satisfaction ($r^2(78) = -0.393, p < .01$), and Workaround Usage ($r^2(78) = 0.423, p < .01$) with the total number of workarounds used. Significant relationships were found among demographic variables, BCMA Satisfaction, and Workaround Usage. Since admitting to the use of workarounds may be a sensitive matter for RNs, measuring BCMA satisfaction may help understand the state of patient safety related to medication administration. Based on high satisfaction scores and low workaround usage, a profile may be developed to identify nurse champions to improve quality of care. Further research is indicated to fully understand these possibilities.
DEDICATION

This dissertation study is dedicated to the many people who supported me through this journey. To my husband, Rob, who has supported me from the moment I mentioned that someday I would like to earn a doctorate degree. You never doubted I could accomplish this and you always stood by me as I committed the time necessary to get it done. To my sons, Nathaniel and Ryan, it may be difficult for you to remember a time when I wasn’t working on school projects. I hope I have served as role model to you and that you have developed an appreciation for higher education, as well as the value of hard work and dedication. It meant so much for me to have you at my defense and I look forward to the day when I will witness your academic achievements. To my parents, Elona and Tony Tordonato, who have always encouraged and supported my educational efforts, all my life. To my friends who offered words of support and encouragement, often asking how my work was going. A special thank you to my friends who entertained my boys by inviting them to your home, took them places or sent your children to my house to keep mine occupied so I could focus on my work. To my co-workers who valued my interest in nursing research and supported my school work with your encouragement. Lastly, I thank the registered nurses at the study hospital who participated in the pilot and completed the study survey. Your insights were eye opening and I am hopeful that your responses, which resulted in the study outcomes, will result in improvements in BCMA systems and ultimately, patient safety and quality of care. What a fantastic contribution we have made to science of nursing!
ACKNOWLEDGMENT

I would like to thank my committee for their commitment, patience and guidance through this work. You all worked so well together, which really facilitated the process. You provided me with answers to my questions, but mostly you prompted me to think, learn, grow and discover through this journey. To my dissertation chairperson, Dr. Joan Such Lockhart, who guided me, yet let me lead. Your responses and comments were always thought provoking, which allowed me to explore and learn what I needed to know. To my internal committee member, Dr. Bonnie Dean, who broaden my horizons in the fields of quality of care, patient safety and technology in health care. So often you provided me with a fresh perspective on things. To my external committee member, Dr. Jonathon Halbesleben, who is so highly committed to understanding workarounds that you were willing to share your expertise and experience with me in my preparation for and during this research study. I have gained an incredible amount of knowledge on this topic because you were willing to work with me. To my statistician, Dr. Steven LaLonde, there is a place in Heaven for you as a result of your willingness to work with me and the exuberant amount of patients that took. Statistics was clearly the area where I felt least experienced. Because of your ability to help me understand, I can now speak intelligently about the statistics in this study. In reality, each one of you uniquely served as the puzzle pieces I needed to complete this work. I cannot imagine completing it with any other team. I am honored to have worked with such experts and to identify each of you as members of my committee. I would be privileged to work with any of you again in the future. Thank you to each of you for all you have been for me.
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Chapter 1

1.1 Introduction

Chapter 1 provides the foundation for this dissertation study. It presents a discussion of the study background, factors prompting this study, and a description of the study purpose. Research questions and operational definitions of variables are defined, and study assumptions and limitations are addressed. This chapter concludes with a discussion of the study’s significance to nursing.

1.2 Study Background

In the past decade, the quality and safety of American healthcare has undergone great scrutiny, prompted primarily by research conducted by the Institute of Medicine (IOM). The IOM made recommendations to the healthcare community which suggested the need for reform of practice, paying particular attention to improving systems by focusing on human factors and implementing technology into practice (Institute of Medicine, 1999). Since then, leaders and practitioners within the healthcare community have examined structures, processes and outcomes and made changes to improve the quality and safety of healthcare. For nurses, this has meant not only modification of nursing practice, but also careful consideration of the competencies required of students during their pre-licensure nursing education preparation. To add to these issues, the Centers for Medicaid and Medicare Services (CMS) and other insurance payers have become interested in the quality of care provided when considering reimbursement for services (Fortin & Zywiak, 2010). In conjunction with this, the United States (US) government has begun to offer incentives for integration of technology into healthcare through the Meaningful Use program (Fortin & Zywiak, 2010). This section will examine the work of the IOM in
greater detail, describe the technology of barcode medication administration (BCMA) as one strategy to improve safety, address the consequence of BCMA known as workarounds, discuss competencies necessary to provide quality and safety education for nurses entering practice, and summarize the implications of Meaningful Use to the introduction of technology into healthcare.

1.2.1 The Institute of Medicine

Just over 10 years ago, the IOM released its report, *Too err is human: Building a safer health system*, describing the state of healthcare in the US as less than acceptable (IOM, 1999). The report startled the country by estimating between 44,000 to 98,000 Americans die each year as a result of medical errors. Errors are defined as “the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim” (IOM, 1999, p.4). Of these errors, over 7,000 were attributed to medication errors. Approximately 2 out of every 100 hospital admissions encountered a preventable medication error that resulted in injury, known as an adverse drug event (ADE) (IOM, 1999). While not all ADEs result in harm, those that do may be costly. In fact, ADEs cost the nation approximately $2 billion annually, as well as the expense related to the consequences of the event suffered by the patient (IOM, 1999). The IOM (1999) also suggested that errors may also be costly because of the loss of consumer trust in the healthcare system that may result after an ADE. The IOM report boldly declared that the state of healthcare was not acceptable, could no longer be tolerated, and that despite barriers, it was “…simply not acceptable for patients to be harmed by the same healthcare system that is supposed to offer healing and comfort” (IOM, 1999, p.3).
While investigating error occurrences, the IOM concluded that “the problem is not bad people; the problem is that the system needs to be made easier” (IOM 1999, p. 49). The IOM suggested that errors highlight where a system had failed and recommended a systems approach to making health care safer, claiming that blaming individuals does not change the system and allows the error to occur again. It became clear that a focus on systems issues was the necessary path to improve quality and safety in healthcare. The science of human factors engineering, a focus on human beings and their interactions with products, devices, procedures, work spaces and the environment, was offered as a framework to examine systems and suggest improvements in quality and safety (Henrik sen, Dayton, Keyes, Carayon, & Hughes, 2008). Specifically, the IOM (1999) referred to the work of James Reason to further understand systems and errors. The IOM describes Reason’s explanation of a systems as “…a set of interdependent elements interacting to achieve a common aim. The elements may be both human and non-human (equipment, technologies, etc.)” (IOM, 1999, p. 52). They go on to discuss how Reason describes errors to be categorized as active, occurring at the frontline with an immediate effect noted, or latent, removed from the frontline, including poor design or structure. The IOM supports Reason’s conclusion that in order to fix systems, focusing on latent errors is more likely to have a greater impact on reducing errors than focusing on active errors (IOM, 1999). Considering Reason’s work and human factors engineering, healthcare was equipped to explore options for improving the quality and safety of American healthcare.
1.2.2. Barcode Medication Administration

It is believed that errors which occur during medication administration account for about 34% of preventable ADEs (Sakowski, Newman, & Dozier, 2008). Specific focus on the medication administration system was identified as a need by the IOM. It is the very process of nurses administering medications to improve patients’ health which puts patient safety at risk. Patient safety is defined as “freedom from accidental injury” (IOM, 1999, p. 58). In order to mitigate this risk to patient safety, technology-driven Barcode Medication Administration (BCMA) was recommended to improve the process of medication administration to patients. BCMA systems are designed to ensure the five rights of medication administration (right drug, right dose, right route, right time and right patient) and prevent the frequency of medication errors through a standardized approach (Bargren & Lu, 2009). Because medication administration errors are considered to be active errors, they are less likely to be discovered before reaching the patient than in any other stage of the medication process (Koppel, Wetterneck, Telles, & Karsh, 2008; Sakowski et al., 2008). Some evidence suggests that BCMA may be effective in reducing medication administration errors (Koppel et al., 2008; Sakowski et al., 2008). This evidence is based on self-reports of medication errors and is difficult to generalize (Patterson, Rogers, Chapman, & Render, 2006).

While there is variability among BCMA systems, the basic premise shared among them includes an encoded bar code that allows for comparison of the medication and patient (Sakowski et al., 2008). Some systems also include a barcode on the patient wrist band and care providers’ identification badge to allow for the identification of the patient receiving the medication as well as the provider who is administering it. BCMA
systems also generate an automatic documentation of the medication administration in the patient’s record, including the time and specific medication details, such as medication name and dose. If there is a mismatch between what is ordered and what is scanned, a warning pops up on the computer screen to alert the nurse to a potential unsafe step in the medication administration process (Patterson, Cook, & Render, 2002). Such warnings are known as “workflow blocks” (Vogelsmeier, Halbesleben, & Scott-Cawiezell, 2008).

Due to the recommendations of the IOM, changes to nursing practice are inevitable, as the use of BCMA alters how nurses administer medications to their patients. In a BCMA system, the five rights of medication administration do not change, but they are validated by the nurse electronically, as opposed to the traditional, manual process of medication administration. BCMA “assists the nurses in confirming the patient’s identity, dose, time and form of medication” (Helmons, Wargel, & Daniels, 2009, p. 1202).

A pioneer in the use of BCMA technology is the Veteran’s Health Administration (VA) who has utilized BCMA to administer medications since 2000 (Patterson et al., 2006). This dramatic change in practice has resulted in a variety of responses or degrees of user acceptance by nurses to the introduction of BCMA into direct patient care. The Technology Acceptance Model (TAM) suggests that user acceptance of technology is determined by the user’s perceived usefulness (PU), or how useful a person perceives the technology to be and their perception of ease of use (PEOU), or how easy the person believes the technology is to use (Alrafi, 2005). User acceptance of BCMA, also known
as *nurse satisfaction*, can be both positive and negative. Positive acceptance is noted when nurses express satisfaction with BCMA systems, as compared to a non-computerized system. This satisfaction is often related to nurse perceptions that BCMA systems are safer than non-technology systems because they allow for easier verification of the five medication rights (Fowler, Sohler, & Zarillo, 2009). Medication administration errors are also easier to detect in a BCMA system due to the automation of the system, hence bringing the nurse’s attention to an active error (Fowler et al., 2009). Negative user acceptance occurs when nurses express dissatisfaction with BCMA systems. When user acceptance is negative, or lacking, the success of new technology is significantly impeded, which means that the success or failure of BCMA use in nursing is dependent on whether or not nurses adapt the technology created to improve patient safety (Dillon & Morris, 1996). In some cases, user acceptance is low because the technology has actually slowed down the medication administration process, such as when retrieving medications from pharmacy in stat or emergency situations. In this case, technology may slow down the process because the pharmacy must process the order before the medication can be dispensed for use (Fowler et al., 2009). In other instances, negative user acceptance has been associated with nurses’ perceptions that the BCMA system is not useful (PU) or that the equipment is not easy to use (PEOU), is confusing, is time consuming or an overall job dissatisfier (Patterson et al., 2002; Zuzelo, Gettis, Hansell, & Thomas, 2008). These perceptions may be related to deficiencies in BCMA systems or processes. When such deficiencies exist, the phenomenon known as “workarounds” may occur.
1.2.3. Workarounds

A workaround is committed when a healthcare provider develops an alternate route to bypass a block in workflow (Ash, Berg, & Coiera, 2004). They are considered deviations in the expected work process and are often prompted by a block in the system design or process. In the case of medication administration, the nurse develops a bypass to the medication administration process, generating major threats to patient safety by creating new paths to ADEs. Such alternate work processes do not follow the expected rules or workflows of the designed process and are designed by the technology user (Koppel et al., 2008). They are often created by nurses as a strategy to ensure that the task at hand is completed as required by their job (Halbesleben & Rathert, 2008).

Workarounds are considered to be a first-order problem solving strategy which only deals with the problem at the present moment and not its root cause (Tucker & Edmondson, 2002; Tucker & Edmondson, 2002). It is the shortcomings in the BCMA design that encourages the use of workarounds (Koppel et al., 2008). Possible consequences of medication administration workarounds include administration of the wrong medication, wrong dose, wrong time or wrong formulation, and not to mention to the wrong patient.

Koppel and colleagues (2008) described 15 types of workarounds to BCMA systems with 31 probable causes to these altered workflows. These BCMA workarounds were condensed into three broad categories: 1) omission of process steps; 2) steps performed out of sequence; and 3) unauthorized process steps. Omission of process steps reflects workarounds where typical steps in the BCMA process are simply not carried out, such as not scanning patient identification bands or the medication itself. In some
instances, nurses will scan an affixed extra copy of a patient’s identification band to avoid disturbing the patient in order to scan the patient’s actual band. Performing steps out of sequence involves documenting medications asynchronously from their actual administration times and includes documenting medications before they are actually administered. Unauthorized process steps include changing process steps or adding new steps to the medication administration process. In many instances, such steps may involve disabling warning or other alarms intended to notify the nurse of a potential error. The causes of such BCMA workarounds have been linked to origins that are technology or task-related, or causes that are associated with organizational policies, patient-related circumstances, or environmentally rooted.

Despite the risk that workarounds pose to patients, nurses engage in workarounds for their own and the patient’s convenience. Nurses’ perceptions regarding the lack of time or the need to drop actions in order to reduce their workload during busy periods were common reasons nurses gave for utilizing workarounds (Koppel et al., 2008; Patterson, Cook, & Render, 2002; Patterson et al., 2006; Vogelsmeier et al., 2008). Nurses may also utilize workarounds to avoid interrupting patients while they are sleeping, visiting with family or speaking with providers (Carayon et al., 2007; Patterson et al., 2002). Workarounds such as administering medication, but not scanning the patient or documenting medication administration until hours after the actual administration time mean that medications and patients are not scanned prior to administration, risking error and patient safety. These and other medication administration workarounds are the result of nurse behaviors and are direct breeches of
the fundamental medication administration process taught to all nurses during their basic educational preparation.

1.2.4. Quality and safety education for nurses

*To err is human* (IOM, 1999) was considered a call to action to make healthcare in America safer. Following the release of this seminal report, the IOM published a series of other reports, challenging healthcare disciplines and offering recommendations to improve quality of care and overall patient safety. One such report challenging healthcare, *Health Professions Education: A Bridge to Quality* (2003), brought forth the need for faculties in medicine, nursing and other healthcare professions to modify curricula to better groom entry-level professionals (Institute of Medicine, 2003). These professionals must be “educated to deliver patient centered care as members of an interdisciplinary team, emphasizing evidence-based practice, quality improvement approaches, and informatics” (Cronenwett et al., 2007, p. 122). Nursing responded to this challenge by developing Quality and Safety Education for Nurses (QSEN), funded by the Robert Wood Johnson Foundation, which was designed to examine and address the gaps in nursing education and identified the competencies required by nurses entering into practice in order to make the necessary changes to improve quality and safety in healthcare (Cronenwett et al., 2007). QSEN developed six competency areas which would provide pre-licensure nursing education programs at all levels (associate degree, diploma and baccalaureate programs) by expounding knowledge, skills and attitudes (KSA) within each competency area. The six competency areas include 1) patient centered care; 2) teamwork and collaboration; 3) evidence-based practice; 4) quality improvement; 5) safety; and 6) informatics. The goal of QSEN is to prepare nurses so all
patients are cared for by professionals who have developed the KSAs within each of these competency areas (Cronenwett et al., 2007).

While all six competency areas of QSEN contribute to ensuring improved medication safety, the competency areas of quality improvement, safety and informatics are specifically focused towards reducing both active and latent errors associated with ADEs. Traditionally, nurses are educated to administer medications utilizing the five rights of medication administration, but they rely on manual processes to ensure that medications are administered safely. Both the IOM and QSEN support the use of informatics to mitigate errors through these competencies (Cronenwett et al., 2007).

The competencies of quality improvement, safety and informatics will be discussed to illustrate how they may contribute to reducing active and latent areas associated with ADEs. Pertinent KSAs will be highlighted as competency components. The competency of quality improvement is defined as “[to] use data to monitor the outcomes of care processes and use improvement methods to design and test changes to continuously improve the quality and safety of health care systems” (Cronenwett et al., 2007, p. 127). In order to understand practice performance and identify gaps between local and best practices, knowledge of variation and measurement in assessing quality of care is necessary. Attitudes which appreciate continuous quality improvement and unwanted variations in care and value measurement of good patient care are required to achieve this competency (Cronenwett et al., 2007).

The competency of safety considers “minimize[ing] risk of harm to patients and providers through both system effectiveness and individual performance” (Cronenwett et
New nurses must possess knowledge of human factors and unsafe practices (such as workarounds), the benefits and limits of safety-enhancing technology (such as BCMA), a culture of safety, causes of errors and their own responsibility/accountability for errors. Necessary skills within the safety competency include demonstrating effective use of technology in practice, reducing risk of harm, communicating hazards and errors, use of error reporting systems and participating in analyzing errors through root cause analysis. Attitudes of safety consider valuing standardized practices, appreciating limits of human performance, valuing one’s own role in error prevention and valuing monitoring of performance by others (Cronenwett et al., 2007).

The informatics competency is concerned with the “use of information and technology to communicate, manage knowledge, mitigate error and support decision-making” (Cronenwett et al., 2007, p. 129). Required knowledge within this competency includes rationales for why information and technology is necessary for nurses to deliver safe patient care and how technology is related to quality care and patient safety. Skills new nurses must possess are application of technology and information to support safe care processes, navigating the electronic health record (EHR), documenting and planning within the EHR, and using information management to monitor outcomes. Attitudes include valuing clinical decision making, error prevention and care coordination technologies and valuing their own involvement in the design, selection, implementation and evaluation of technologies which support patient care (Cronenwett et al., 2007).
1.2.5 Meaningful use

Beginning in 2011, as promised by the Health Information Technology of Clinical Health (HITECH) provision of the American Recovery and Reinvestment Act of 2009 signed by President Obama, healthcare providers and qualifying hospitals who can demonstrate meaningful use of certified EHR technologies will be eligible for incentive payments from CMS. These incentives are sizeable with the expected range of such payments to hospitals to fall between $4-8 million over a multiyear period (Bigalke & Morris, 2010). With medication administration documentation as a part of the EHR for inpatients, considerable pressure will exist for hospitals to implement BCMA systems in order to ensure patient safety. This will occur because payers are refusing to pay for poor quality care, such as medication errors (Fortin & Zywiak, 2010). To prevent loss of payment, hospitals will be required to implement clinical decision support, as outlined by HITECH. Effective implementation will be required in order to ensure meaningful use of the EHR.

1.3 Study Purpose

The purpose of this study is to understand the relationship between registered nurse (RN) satisfaction, also known as end-user acceptance, with their BCMA system, PU, PEOU and RN BCMA workaround usage. The Technology Acceptance Model (TAM) will be used as a framework to understand the relationship (Alrafi, 2005). First, the direct relationship between RN satisfaction with BCMA and RN workaround usage will be determined. A more in-depth exploration will determine other relationships between these variables. In congruence with the TAM, an exploration of the relationship of PEOU and PU to BCMA satisfaction and workaround usage will also be conducted.
1.4 Variable Definitions

For this study, the following terms have been conceptually and operationally defined:

1. **End-User Acceptance (Satisfaction)**

   Conceptual Definition: End-User Satisfaction is defined as “the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support” (Dillion & Morris, 1996; Hurley et al., 2007, n.p). The terms *end-user acceptance* and *satisfaction* can be used interchangeably. From this point forward, the term *satisfaction* will be used to imply end-user acceptance. In this study, the end-user will always be an RN.

   Operational Definition: Satisfaction will be measured by the sum of the scores on the following subscales from the Workaround Usage and Satisfaction with Barcoding Instrument for Nurses [WUSBIN]: 1) the Nurse Satisfaction Subscale: Efficacy; 2) Nursing Satisfaction Subscale: Safety and; 3) Nursing Satisfaction Subscale: Access.

2. **Barcode Medication Administration (BCMA) Workaround**

   Conceptual definition: BCMA is a “point-of-care technology that integrates nurse scanning of bar-coded medications with the patient’s electronic medication administration record”. (Ash et al., 2004; Koppel et al., 2008; Hurley et al., 2007, p. 343). This practice provides nurses with a safety check of the five rights of medication administration. BCMA Workarounds are an alternate route, developed by an end user, to bypass a block in workflow. This alternate route does not follow the expected rules or workflows of the designed process.
Participating in the practice of BCMA workarounds will be referred to as *workaround usage*.

Operational definition: BCMA Workarounds will be measured by the score on the Workaround Subscale: Workaround Types of the WUSBIN.

3. Perceived Ease of Use (PEOU)

Conceptual definition: PEOU is “the degree to which the user believes that using the system will be free from effort” (Dillion & Morris, 1996, n.p.).

Operational definition: PEOU will be measured by the sum of the scores on the following WUSBIN subscales: 1) the Workaround Subscale: Block Perceptions; 2) Workaround Subscale: Altering Processes; 3) Workaround Subscale: Procedural Preferences and; 4) Workaround Subscale: Computer Anxiety.

4. Perceived Usefulness (PU)

Conceptual definition: PU is “the degree to which a user believes that using [a] system will enhance his or her performance” (Dillion & Morris, 1996, n.p.).

Operational definition: PU will be measured by the WUSBIN score on the Workaround Subscale: Motive to Assist Patients.

1.5 Research Questions

The following research questions will guide this study’s inquiry:

Question 1. What is the relationship between registered nurse (RN) *satisfaction with barcode medication administration (BCMA)* and their *workaround usage*?
Question 2. Does BCMA satisfaction affect *perceptions of ease of use (PEOU)* of BCMA, *perceptions of usefulness (PU)* of BCMA and workarounds used, as measured by the WUSBIN?

Question 3. Does workaround usage affect *PEOU* of BCMA, *PU* of BCMA and workaround used, as measured by the WUSBIN?

Question 4. What is the relationship between levels of BCMA *satisfaction* and *workaround usage* with the demographic variables of: 1) gender; 2) age; 3) highest nursing degree earned; 4) number of years employed as an RN; 5) number of years employed as an RN at the study hospital; 6) shift worked; 7) schedule worked; 8) self-rated computer skills; 9) presence of computer at home and; 10) self-rated skill of obtaining patient information from the study hospital computer system?

1.6 Assumptions

Several assumptions are made by the researcher during this study.

1. Since BCMA users are all human beings and subject to variations and mistakes in their daily practice, all BCMA users (RNs) participate in some type of workarounds, whether this participation is conscious or unconscious.

2. All RNs who participate in this study received appropriate training to use the hospital’s BCMA system and therefore, are competent to use it.

3. All nurse subjects pass medications confirming the five rights of medication administration and are familiar with the hospital’s medication administration policy.
4. Given that no subject identifiers will be collected with the study data, subjects answering the research questions will give honest answers that will accurately reflect their nursing practice.

5. Nurses have opinions which describe their satisfaction with the hospital’s BCMA system and have perceptions about how useful the system is and how easy the system is to use.

1.7 Limitations

There are identified limitations to this study that will be addressed and will be minimized in the design of the study. The first limit considers the accuracy of the data collected in this study. It is important to acknowledge that the use of workarounds in nursing practice may be considered a sensitive subject for inquiry since workarounds are deviances from practice standards. While study subjects will be assured that their identity cannot be linked to their responses, they may still not feel comfortable to be completely honest when answering questions about their practice. Instead, they may feel they should give responses which are socially acceptable (Waltz, Strickland, & Lenz, 2010). If they are not honest with their responses, study results could be inaccurate. Strategies to minimize this will be included in the study design and described in more detail in Chapter 3.

A second limitation of this study includes the variety of patient care areas in this hospital because different patient care areas have variations in workflows, which may be reflected in BCMA practices. For example, outpatient areas will not administer medications on the night shift because they are not open during those hours. BCMA practices may be different at night because of the darker environment and desire to allow
patients to experience uninterrupted sleep. It is possible that there may also be variations between units as it relates to their levels of satisfaction and workaround usage. Nurses on some units may be more satisfied than nurses on other units with the BCMA system, as well as nurses on some units may use the BCMA system more frequently because their patients receive more medications or due to higher patient census counts. Data from this study will be not stratified by unit type, which may affect data analysis interpretation, as it will not be possible to know which data come from nurses working on a particular unit. If data were stratified by unit type and only a small number of subjects completed the survey on a particular unit, the potential for subject identification exists.

1.8 Study Significance to Nursing
With heightened attention to the quality and safety of healthcare in America, studies are needed to enhance the understanding of processes designed to ensure reliable systems of medication administration for nurses. To this end, much attention has been focused on ameliorating ADEs through the use of technology. If nurses are not satisfied with using technologies in their practice, there may be a risk of working around the system designed to keep patients safe. This study intends to explore this concern with proposed significance to clinical nursing practice, nursing informatics, nursing education and nursing administration.

1.8.1 Clinical Nursing Practice
The greatest benefit of this study is related to clinical nursing practice with the ultimate outcome of a significant reduction in the number of ADE occurrences. Uncovering a positive correlation between nurse satisfaction with BCMA and workaround usage would direct focus on improving nurse satisfaction with BCMA
systems to reduce the use of workarounds, with a goal of creating a relationship with a negative correlation. Among groups of healthcare professionals, nurses bear the greatest level of responsibility for medication administration, making them the key stakeholders of this process. In order to be responsible for this part of nursing practice, nurses must have a vested interest in conducting and understanding research designed to impart more knowledge about the safety and quality of medication administration. As key stakeholders, nurses are positioned to utilize evidence to design new processes and ultimately to alter their own practice by improving patient safety. Nurses are conditioned during their basic educational preparation to ensure quality and safety to patients and the value of this is evident within the nursing literature, standards of practice and accreditation guidelines (Cronenwett et al., 2007). In order to ensure that this evidence is kept current and reflects current nursing practice, understanding factors which may impact patient safety and quality of care is the responsibility of the nursing profession.

1.8.2. Nursing Informatics

The specialty of nursing informatics is interested in how nurses use technology within practice. Understanding which type of workaround is associated with different levels of satisfaction will help to identify when staff nurses are dissatisfied with the BCMA system, potentially indicating the need for systemic modification. Rectifying such satisfaction issues in a timely manner could be crucial to patient safety. It is the responsibility of nursing informatics specialists to understand the factors influencing nurse satisfaction with BCMA in order to reduce workaround usage. Additionally, understanding how nurses’ satisfaction or acceptance of BCMA impacts the use of
BCMA workarounds will provide information to develop stronger systems that may result in safer and higher quality care for patients.

1.8.3 Nursing Education

As healthcare pushes forward to bring technology to the bedside, it is important for nurse educators in the academic and staff development settings keep abreast of these changes and ensure integration into their program curriculum. Nursing students will need to be educated about the use of technology during the medication process from the time that this topic is introduced to them. Providing the knowledge, ensuring the skills and inspiring the attitudes that utilization of technology is the safest method for medication administration must be integrated into today’s nursing curriculums. Schools of nursing will need to consider the acquisition of equipment for simulation laboratories so students may learn the use of BCMA to acknowledge the five rights of medication administration. It is also important that schools of nursing are in communication with their clinical sites to ensure they are teaching compatible processes so students are well prepared to pass medications using the proper steps and following the appropriate procedures while administering medications. In order to ensure that faculty are prepared to provide their students with the most current information and encourage evidence based practice, understanding the relationship between BCMA Satisfaction and Workaround Usage will help to develop the framework needed to shape knowledge, skills and attitudes necessary to establish competence for the task of safe medication administration.

Nurse educators working in staff development should be aware of issues which may lead nurses to utilize workarounds in their daily practice. Integrating these issues in new employee orientation and inservices/annual competencies may become necessary as
the use of technology during medication administration becomes more common. Awareness of a relationship between BCMA Satisfaction and Workarounds Usage may provide educators with a method to address medication errors in a non-threatening manner.

1.8.4. Nursing Administration

Understanding the relationship between nurse PU and PEOU of BCMA systems and nurse BCMA satisfaction and workaround usage is significant knowledge to those who purchase or determine BCMA systems for hospitals. Not only would it be fiscally irresponsible to purchase a BCMA system with low nurse PU or PEOU, but it may also jeopardize patient safety and quality of care if these variables are predictors of workarounds. Meaningful use incentives may also motivate nurse administrators to ensure that BCMA systems are utilized properly in order to reap this benefit. A portion of the money paid to hospitals for meaningful use should be reinvested in ensuring that nurses have BCMA systems in place which have high PU, PEOU and satisfaction levels.

Nurses may hesitate to admit to BCMA workaround usage because they may fear repercussions for undesirable behavior. Nurses may be less hesitant to describe their satisfaction level with BCMA systems, as this may seem more benign than admitting workaround usage. If satisfaction level can predict workaround usage, nurse administrator can measure the satisfaction of their nursing staff with the BCMA system in order to understand workaround usage, and ultimately decrease the risk to patients for ADE occurrence. Understanding characteristics of nurses based on satisfaction levels, workaround usage and PU and PEOU may help nurse administrators identify nurses
within their staff who are more likely to utilize workarounds in practice, thereby affording them the opportunity to monitor such behaviors and proactively prevent them.

This study is designed to address these significant issues and produce knowledge which is helpful in improving nurse satisfaction with medication administration systems and reducing workaround usage while simultaneously keeping patients safe. If nurses are not satisfied with the BCMA system in their work environment, it is possible they are more likely to utilize workarounds, which put patients at risk for harm.

1.9 Summary

The IOM (1999) has declared the need to improve patient safety and quality of care in America and has identified medication safety as a top priority. A predominate strategy to address this need is the utilization of information technology within the healthcare setting. One approach to this safety concern is the implementation of BCMA in hospitals. This considerable practice change has resulted in a variety of satisfaction responses from nurses. When nurses perceive blocks in the BCMA system, they develop workarounds to circumvent the system in order to provide care. Unfortunately, the use of such workarounds jeopardizes patient safety and quality of patient care. It is necessary to understand the relationship between nurse satisfaction with BCMA and their use of workarounds in an effort to improve practice, maintain patient safety and enhance the American healthcare system.
Chapter 2

2.1 Introduction

This chapter will include a review of the available research and other literature related to nurse satisfaction with barcode administration (BCMA) and barcode administration workarounds, a body of literature that is limited, secondary to the newness of BCMA in nursing practice. First, pertinent literature related to the study’s theoretical framework, the Technology Acceptance Model (TAM), will be described. Next, a review of past research related to the safety of BCMA and its impact on the medication administration process and nurse satisfaction with this technology will be presented. Finally, a discussion of the literature related to nurse satisfaction with BCMA and BCMA workarounds will be provided.

A literature search related to BCMA-WA was conducted in an attempt to understand this behavior among nurses. Search terms utilized were *workaround(s)* (and other forms: work around(s), work-around(s)), *medication administration, medication errors, violations, shortcuts, barcode medication administration*. The terms *nurse satisfaction and BCMA* were searched independently and together. Subsequent reviews were conducted to understand how TAM can be applied to healthcare and nurse satisfaction with BCMA technology. Search terms were *TAM, Technology Acceptance Model*. These searches utilized the databases CINAHL, PubMed, MEDLINE, PsychINFO and the Database of Abstracts of Reviews of Effects and Health Technology Assessment from 1990-2011. The current literature related to BCMA workarounds and nurse satisfaction with BCMA is limited, spanning only over the past 12 years. Among the existing studies,
research utilizing qualitative or mixed methods methodologies is most prevalent and focuses on understanding the types and causes of BCMA workarounds.

2.2 Theoretical Framework: Technology Acceptance Model

The Technology Acceptance Model (TAM) was developed by Davis in 1989 to explain and predict the acceptance and usage of information technology (Davis, 1989). Its purpose is to “provide a basis for tracing the impact of external factors on internal beliefs, attitudes and intentions” (Davis, Bagozzi, & Warshae, 1989, p. 985). Influenced by Ajzen and Fishbein’s (1975) Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), TAM addresses how users are able to accept and use technology (Alrafi, 2005). The TRA is a social-psychological/behavioral theory which strives to understand a variety of behaviors (Holden & Karsh, 2010). TAM suggests that the greatest antecedent to the use of technology is one’s behavioral intention (BI) to use it. This is more commonly referred to as user acceptance, or end-user satisfaction (Holden & Karsh, 2010). BI is directly influenced by attitude (ATT), which is determined by two variables, perceived usefulness (PU) and perceived ease of use (PEOU) (Alrafi, 2005). Figure 2.1 depicts the TAM and how end users come to accept and use any given technology. (Davis et al., 1989).
Figure 2.1. Technology Acceptance Model (TAM) (Davis et al., 1989, p. 985). Adapted with permission of the author (Appendix 4).
2. 2.1. Perceived Usefulness

Perceived Usefulness (PU) is defined as “the degree to which a person believes that using a particular technology will enhance his or her job performance” (Alrafi, 2005, p.2). People are more likely to use something if they perceive it will help them to complete a job (Davis, 1989). PU is known to be a strong determinant of behavioral intentions, supported by standard regression coefficients of around 0.6 (Venkatesh & Davis, 2000). While users may find a technology to be useful, they may also determine it to be difficult to use, outweighing its PU.

2.2.2. Perceived Ease of Use

Perceived Ease of Use (PEOU) is considered to be “the degree to which a person believes that using a particular technology will be free of effort” (Alrafi, 2005, p. 2). It is supported by Bandura’s work on self-efficacy which considers how well individuals judge their ability to complete a course of action within a prospective situation (Bandura, 1982). PEOU is known to have a direct effect on user PU and intention to use a technology. It is an initial hurdle to overcome in order to accept, adopt and use a technology system (Venkatesh, 2000).

When considering PEOU of a new technology, users anchor their perceptions of the technology to their general beliefs. Venkatesh (2000) describes three anchors which users consider when determining such perceptions: control, intrinsic motivation and emotion. Anchors are general information that users rely on in the absence of specific knowledge. The first anchor is control, both internal and external. Internal control is based on what users believe to be their ability to perform a specific task, known as self-efficacy. External control considers perceptions of technology resources, known as
facilitating conditions (i.e., support staff availability when learning a new technology). The second anchor in determining the PEOU is *intrinsic motivation*, which considers perceptions of pleasure and satisfaction from participating in a behavior. More specifically, when considering computerized technology, *intrinsic motivation* is described as computer playfulness. The final anchor is *emotion*, which is described by the negative affective reaction known as computer anxiety that is portrayed as apprehension or fear when considering using a computer. All three of these anchors are directly related to general perceptions of computer use (Venkatesh, 2000).

As users gain more experience with a technology, they are expected to adjust their PEOU. Venkatesh (2000) describes that PEOU is still anchored to users’ general beliefs, but adjustments are made. User self-efficacy and computer anxiety are expected to remain stable. Knowledge and anxiety are considered to be objective usability, allowing users to compare actual usage effort to perceived effort to complete a task. The next adjustment is related to *external control* and suggests that firsthand experience with a technology allows for the user to judge the actual external controls when considering the ease of use of a system. *Intrinsic motivation* adjusts to users’ perceived enjoyment of using the technology. With this adjustment of PEOU, users consider such factors as the effectiveness of support staff while learning a new technology and how enjoyable the technology is, despite any potential performance consequences.

2.2.3 Framework Conclusion

In the early years after TAM’s development, Davis found that while PU and PEOU were associated with both self-reported current and future use of a technology, PU was found to have a significantly greater correlation with technology usage than PEOU
(Alrafi, 2005; Davis, 1989). When all else is held constant, a positive BI towards technology is more likely to develop when a positive ATT is had (Davis, Bagozzi, & Warshae, 1989).

While the TAM is tailored to understand acceptance of computer technologies, it is not specific to healthcare. It is, however, “the most widely applied model for user acceptance and usage” (Venkatesh, 2000, p. 343) and industries outside of healthcare consider it to be the gold standard to understanding user acceptance of technology. The value of the tool is its ability to predict attitudes, satisfaction and usage of technology (Alrafi, 2005). This model has been noted to be robust over time, across a variety of settings and among a variety of populations and technologies (Venkatesh, 2000). Although its original intent was to measure user acceptance of computers, the theory has been widely used in healthcare in recent years. Considering nurses to be the users, the theory allows for exploration of nurses’ acceptance and actual usage (or nonusage) of BCMA, and therefore, their satisfaction with the technology. Based upon these attributes, this theory provides the appropriate framework for this study.

2.3 The Safety of Barcode Medication Administration

While most medication errors are benign and low risk to patients, there are medication errors that are severe and even deadly (Institute of Medicine, 1999). The introduction of information technology into healthcare was intended to provide patients with a safe environment for care delivery. Computer applications are best utilized with automated work processes (Ash, Berg, & Coiera, 2004); however, the process of medication administration is anything but automated. Medication administration is
highly complex, making it possible for the nurse to both hide and create errors. At times, these errors can be silent and invisible (Ash et al., 2004).

BCMA was integrated into healthcare in order to improve patient safety by reducing the number and severity of medication administration errors. A panel of three pharmacists, two registered nurses (RNs) and a physician, evaluated 945 total medication errors records detected by a BCMA system which involved 212 drugs and 564 scenarios (Sakowski, Newman, & Dozier, 2008). Each scenario was rated on a 0-10 analogue scale, where 0 indicated no effect and 10 indicated death. Ratings were based on the situation’s potential to cause harm or adverse effects. The panel determined that 9% (n = 81) of medication errors reviewed were expected to result in moderate to severe adverse effects (8% moderate; 1% severe) and 91% (n=864) were rated as having minimal severity potential (Sakowski et al., 2008). In situations where the user continued with the administration despite the BCMA system warning, the rating was less likely to rated moderate or severe. *No order* errors were significantly more likely to be rated moderate or severe than other error types. Twenty percent of the errors committed involved the top five medications (from a list of 30) identified as *heightened risk for patient harm*. Of these risky medications, 74% were narcotics. The study outcomes supported the potential patient safety benefits of BCMA by extrapolating the findings to estimate that 198,000 medication errors were prevented by BCMA, of which 17,000 medications would have produced moderate to severe error (Sakowski et al., 2008).

Utilizing human factors as a supporting framework, an academic hospital explored the use of BCMA technology by nurses (Carayon et al., 2007). A human factors engineer and a pharmacist directly observed 18 different sequences for medication
administration during 59 different observations ending in administration. Of these observations, only 23 subjects were observed to follow the correct BCMA process, with 21 medications administered without being barcoded. These researchers observed potentially unsafe medication administration practices related to not scanning the patient. These unsafe practices included the following: scanning the patient after the administration, undocumented administration, recording a medication that was not administered, scanning the chart rather than the patient, and ignoring the alarm that the doses exceeded the order and administering the medications anyway (Carayon et al., 2007).

2.4 The Impact of BCMA on Nursing Care

Undoubtedly, implementing BCMA changes the workflow of the nurse during medication administration. A time-motion study consisting of 232 two-hour direct observation sessions on 37 nursing units was conducted to evaluate the impact of BCMA on nursing workflow (Poon et al., 2008). Half of the observations were made on units utilizing BCMA, while the other half of the observations were on units where BCMA had not yet been implemented. The study concluded that BCMA did not increase the amount of time for medication administration; however, nurses spent more time providing direct patient care after BCMA implementation, and less time on inefficient activities. The study concluded that BCMA allowed nurses to streamline their work, allowing time for more important activities (Poon et al., 2008).

A case study conducted in a high risk labor and delivery unit examined the BCMA process utilizing a mixed approach through direct observation and the creation of process maps; the researchers concluded that there are more steps in the BCMA process
than in the process of medication administration without barcoding (Bargren & Lu, 2009). During this evaluation, 17 gaps in the medication administration process were noted, some of which were filled through the utilization of workarounds by nurses. These gaps were categorized as technical gaps, human interaction gaps and content workflow gaps (Bargren & Lu, 2009). Recommendations such as decreasing the number of insignificant warnings and removing unneeded data or technical steps from the screen were made to reduce the use of workarounds. Because workarounds are unintended at the time of work system development, nurse managers should be alert to continuously evaluating the BCMA practice of the staff (Bargren & Lu, 2009).

A third study, describing how technology influenced the work of the RN, also suggested that the introduction of technology in the patient care setting impacted how nurses administered medications. Thirty-one medical/surgical nurses with at least one year of experience and working full or part time were interviewed using focus groups about the benefits and challenges associated with the introduction and integration of new technologies into their nursing practice (Zuzelo, Gettis, Hansell, & Thomas, 2008). The researchers determined that technology does enhance nursing practice because it improved processes, patient outcomes and the overall work environment. When faced with technology problems, nurses were more likely to bypass them than to solve them. The researchers noted that gaps in the technology system potentially increased errors and led to nurse dissatisfaction (Zuzelo et al., 2008).

Another study that focused on a variety of technologies, explored how nurses’ beliefs of health information technology (HIT) predicted their perceptions of quality care (Karsh et al., 2009). TAM was one among a variety of frameworks from which this
cross-sectional survey study was grounded. Three user beliefs were measured in this study: 1) fit; 2) subjective norms and 3) computer self-efficacy. The first belief, fit, refers to interactions that include task, technology, and user factors such as ease of use, compatibility, and usefulness. Subjective norms, the second belief, consider the perceived social pressure of important others to use HIT. Lastly, computer self-efficacy refers to how users perceive their skill and comfort with general computer technology. Nurses at two urban hospitals participated in this study, 121 nurses from Hospital A and 75 nurses from Hospital B. Significant relationships were found between nurses’ perceived ability to use technology and their perceived ability to provide quality care. When perceived HITs are perceived to fit, nurses’ perceptions of the quality of care provided by individuals and entire nursing units are high. This study concluded that it takes a balance between people and technology to determine quality of care.

In addition to nurses’ perceptions of BCMA, nurse opinions of BCMA system effectiveness in reducing preventable adverse drug events (ADE) have also been explored (Morriss, Abramowitz, Carmen, & Wallis, 2009). A prospective cohort study of RNs (N= 46) in a 36-bed Neonatal Intensive Care Unit (NICU) found that implementation of a BCMA system significantly reduced the number of ADEs within the unit. Nurses recognized that the system improved patient safety, although it was not fool proof. The BCMA system in this unit did not create a high level of occupational stress for the nurses, except when the BCMA system broke down. Unfavorable opinions of the nurses in this study included concerns such as the time spent administering medications with the BCMA system. At least two-thirds of the nurses felt the BCMA system distracted them
from other patient care activities. While workarounds were not measured in this study, at least half of the nurses stated that they knew that workarounds occurred in their unit.

The thinking patterns of nurses (N= 40) during the process of medication administration was studied using a qualitative approach at a tertiary care teaching hospital in the northeastern United States both before and after the implementation of BCMA (Eisenhauer, Hurley, & Dolan, 2007). Data collection was conducted via semi-structured interviews. The researchers identified ten descriptive categories of thinking using content analysis. The categories demonstrated the intellectual complexity of medication administration and included: communication, dose time, checking, assessment, evaluation teaching, side effects, workarounds, anticipatory problem solving and drug administration. The thinking of most nurses did not change after BCMA. Differences were only noted in the area of checking, where areas of concern were different. Nurses in this study were happy with the ease of finding patient information and experiencing less ambiguity, frustration and room for error than before BCMA (Eisenhauer et al., 2007).

Although technology is intended to improve nursing care, there is evidence to support that technology such as BCMA may also have negative effects on nursing care. Ethnographic observations to determine if negative, unintended side-effects were the product of BCMA introduction were studied at four Veterans Health Administration hospitals (Patterson, Cook, & Render, 2002). Sixty-seven observations of nurse-BCMA interactions were conducted over 21 hours with seven nurses at one hospital and 60 hours with 26 nurses at three other hospitals. Observations were classified into 12 categories.
Five negative, unintended side effects that had the potential to create new adverse drug events, were observed and included: 1) nurse confusion of automatic medication removal by BCMA; 2) degraded coordination among nurses and physicians; 3) dropping of activities by nurses when they were busy in order to reduce their workload; 4) heightened nurse anxiety regarding the monitoring of timeliness of medication administration; and 5) a decreased ability to deviate from routine sequences.

In another study, the BCMA processes in two medical/surgical and three intensive care settings were prospectively observed one month before and three months after the initiation of BCMA (Helmons, Wargel, & Daniels, 2009). Medication administration accuracy was measured using the California Nursing Outcomes Coalition (CalNOC) accuracy indicator. After analyzing over 1,000 opportunities for error both pre- and post-BCMA implementation, it was found that BCMA reduced medication administration errors in the medical/surgical units, but did not reduce errors in the intensive care setting. Researchers believed the medical/surgical units had a greater number of errors than were noted in the ICU at the study’s baseline; therefore, their reduction in errors was greater in the medical/surgical units post BCMA implementation. Additionally, error types were discovered to be inconsistent among different patient care areas (Helmons et al., 2009).

2.5 Nurse Satisfaction with BCMA and Other Medication Administration Systems

With such a considerable change in the nursing practice of medication administration, there is a risk of dissatisfaction and discontentment when BCMA is implemented. A pre- and post-implementation examination of satisfaction among medical/surgical, intermediate and intensive care nurses utilizing BCMA and electronic medication administration records (eMAR) was conducted (Hurley et al., 2007). The Medication
Administration System—Nurses Assessment of Satisfaction Scale (MAS-NAS) was used to measure nurse satisfaction with the BCMA and eMAR system (Hurley et al., 2007). According to survey and interview results, the nurse participants (N= 143) were very satisfied with the new BCMA/eMAR system, as opposed to their previous system without technology. The nurse participants believed the new BCMA/eMAR system allowed for better completion of the five rights of medication administration (correct patient, medication, dose, route and time) and that the system would detect potential mistakes early in the medication administration process (Hurley et al., 2007).

Supporting these results, another study also found that nurses (N=68) were satisfied with the safety that BCMA provided in preventing errors by easily allowing confirmation of the five rights of medication administration (Fowler, Sohler, & Zarillo, 2009). BCMA systems have also been cited in the aforementioned study of 46 NICU nurses as promoting the professionalism of nurses and contributing to overall job satisfaction (Morriss et al., 2009). Not only were nurses more satisfied with BCMA than with their pre-VCMA medication administration system, but the NICU where these nurses practiced noted a significant reduction in the number of ADEs after BCMA. In addition to high levels of satisfaction, these NICU nurses also experienced lower occupational stress scores after implementation of the BCMA system (Morriss et al., 2009). Dissatisfaction with BCMA stemmed from the wait required by pharmacy when stat medications were ordered. The change in process required pharmacists to profile the medication, a quicker process before BCMA. Nurses were also dissatisfied with the BCMA system because it did not speed up the medication administration process in order
to provide them with more free time to spend with their patients (Fowler et al., 2009; Morriss et al., 2009).

In another research study exploring nurse satisfaction with medication administration systems other than BCMA, the relationships between emotional exhaustion and workarounds related to medication administration by nurses was examined (Halbesleben, 2010a). This survey study (N=243) was conducted in two Midwestern acute care hospitals and measured emotional exhaustion using the Maslach Burnout Inventory, workarounds, and nurse satisfaction with medication administration processes, using the MAS-NAS (Halbesleben, 2010a). Nurses who described themselves as being exhausted were more likely to use workarounds than those who were not exhausted. A weaker relationship was found between exhaustion and workarounds in nurses who were satisfied with the medication administration system. This study suggested that nurses who described themselves as burned out were suboptimal problem solvers. The researcher suggested that the use of workarounds during medication administration could be diminished by reducing exhaustion and improving nurse satisfaction with the medication administration. One such strategy to reduce exhaustion and improve satisfaction was the implementation of super users of the medication administration system (Halbesleben, 2010).

The MAS-NAS was utilized again to measure nurse satisfaction with BCMA and the electronic medication record (e-MAR), pre- and post- implementation of the system, as it relates to efficacy, safety and access (Tremblay, 2010). Nurses in a 200-licensed bed community hospital (n = 90 (31%) pre-BCMA implementation; n=102 (33%) post-BCMA implementation and n= 31(12%) both pre- and post-BCMA implementation)
completing the on-line and paper surveys did not have a significant difference ($p=.05$) in their levels of satisfaction before or after the BCMA system and e-MAR were implemented. Surveys were conducted three months apart without any statistically significant differences in nurse satisfaction scores related to the efficacy, safety or access of the new system (Tremblay, 2010). Nurses were satisfied with the medication administration system before the introduction of BCMA, with positive trends towards higher levels of satisfaction after BCMA was implemented in the nine clinical areas (Tremblay, 2010).

2.6. Barcode Medication Administration Workarounds

When a work design such as BCMA fails to meet its intended end, nurses are faced with a choice—the choice to resolve the failure or to find an alternative path to complete the medication administration. When the nurse chooses to find an alternate path to administer medications, such as a BCMA workaround, first-order problem solving skills are utilized. Alternatively, when the nurse attempts to change the system so the problem does not reoccur, second-order problem solving skills are utilized (Tucker & Edmondson, 2002). The intention of the nurse at this point becomes crucial. A choice must be made regarding how to proceed. Clever alternative approaches, such as BCMA workarounds, permit the co-existence of information technology and the avoidance of processes that the nurse deems as unrealistic. Such situations undermine patient safety (Ash et al., 2004). This situation raises questions and concerns regarding the risks that nurses create when they choose to follow a BCMA workaround as opposed to using the technology as it was intended.
When considering workarounds in general (not specific to BCMA), it has been noted that the unsafe behaviors which workarounds represent are recognized by the nurse, but the nurse may not view the workaround as a hindrance to completing the intended job (Halbesleben, 2010b). The impact of workarounds is generally not recognized by the nurse immediately because a single episode may not lead to injury or error; however, consistent use of workarounds in practice will increase the risk for injury or error to occur (Halbesleben, 2010b). While not specific to BCMA, Halbesleben (2010) suggests that general workarounds performed by health care workers may be prompted by work exhaustion and burnout, which are positively associated with occupational injuries. A cross-lagged panel study of health care professionals in two hospitals (137 nurses at hospital one and 101 nurses at hospital two) established a link between exhaustion, general workarounds and safety outcomes. Nurses feeling depleted of resources were at higher risk for choosing to use a workaround if they could still complete their work. This general knowledge is important to take into account when considering workarounds specific to BCMA.

The use of BCMA workarounds by nurses to solve technology gaps has prompted researchers to look at this phenomenon directly. A typology of BCMA workaround was developed in order to better understand the existing categories of this creative workflow (Koppel, Wetterneck, Telles, & Karsh, 2008). In this typology study, 15 types of workarounds related to BCMA were categorized into three steps: 1) omitted steps, 2) incorrect sequence, and 3) unauthorized steps (Koppel et al., 2008). Thirty-one separate probable causes of these identified workarounds were categorized into technology related, organizational, task related, patient-related and environmental causes. The
researchers concluded that workarounds may result from more than one cause, and that causes may be associated with multiple workarounds. However, most workarounds are utilized in an effort to save time. Possible consequences of BCMA workarounds include administration of the wrong medication, dose, time and formulation (Koppel et al., 2008).

An earlier study designed to identify the types and extent of BCMA workarounds was conducted in long-term and acute care settings (Patterson, Rogers, Chapman, & Render, 2006). Prospective ethnographic observations and interviews were conducted with 15 acute care and 13 long term nurses. Two major categories of workarounds were identified: 1) patient identification; and 2) medication identification. BCMA was noted to increase efficiency of medication administration, but created new potential paths to adverse events. Workarounds were noted to be different in the two settings, with more workarounds occurring in the long term setting. Researchers concluded that some workarounds actually created a greater risk of adverse events then the risks that existed before BCMA was implemented (Patterson et al., 2006).

As part of a larger study, a qualitative evaluation was conducted in nursing homes to describe the underlying nature of workarounds in relation to technology implementation of an electronic medication administration record and to identify the potential risks of workarounds on medication safety (Vogelsmeier, Halbesleben, & Scott-Cawiezell, 2008). Data were collected via direct observation of nurses in nursing homes and team meetings before (N= 43) and after (N= 45) technology introduction. The researchers discovered that workarounds existed in two patterns 1) those related to blocks introduced by technology; and 2) those related to organizational processes that had not been reengineered to integrate effectively with the implementation of technology.
Workarounds were described as first order problem solving methods, indicating that they were a solution that did not resolve the root cause of the block in workflow, but allowed immediate resolve of the problem. Staff is effective in creating these, rather than utilizing second order problem solving methods that are permanent and resolve the root cause of the issue.

Factors contributing to the improper verification of medication barcodes were explored in a Dutch hospital (Van Onzenoort et al., 2008). The actual use of barcode verification was recorded on a daily basis for three weeks. The percentage of medications that were actually barcoded was calculated based on the total number of medication administrations. Using this process, it was noted that only 55.3% of the over 15,000 medications that should have been barcoded were actually scanned. Rationale that was provided by nurses for nonscanning included an increased workload secondary to a shortage of time and technical problems, and a lack of barcodes on all medications. This study found that drugs were administered on average, 51 minutes later than prescribed using the BCMA system. A small percentage of nurses stated a lack of awareness of the safety created by BCMA systems in preventing medication errors.

An examination of the medication administration process among ICU nurses at four acute care hospitals (N = 58) was conducted to understand the rework (duplication of efforts) and workarounds which occurred in hospitals during medication administration, including BCMA (Halbesleben, Savage, Wakefield, & Wakefield, 2010). Of these two hospitals, one was designated Magnet®, the other was not. Observations and semi-structured interviews uncovered 12 reported blocks in the process and were categorized as information exchange, information entry and internal supply chain issues. Information
exchange was related to the communication which occurs concerning medication orders. Information entry considered problems that occurred during the entry of order information into the hospitals’ technology systems. Internal supply chain barriers were the result of problems receiving the medication desired. Workarounds were most common when nurses encountered internal supply chain barriers. During the interviews, nurses expressed that the medication administration barriers impacted all five rights of medication administration. Blocks related to workarounds most commonly involved the rights of right route, medication and dose. This study advocates for collaborative system approaches to address rework and workaround related practices, and the decentralization of pharmacists to support nurses so they encounter less barriers, potentially resulting in less rework and workaround practices (Halbesleben et al., 2010).

2.7 Gaps in the Literature

Given the relative newness of BCMA in nursing, the literature is full of unexplored fields. Existing research has investigated how BCMA systems impact medication safety and nursing practice. The development of BCMA workarounds has been identified as a breach of patient safety. Every time a nurse chooses a BCMA workaround over institutional policy, risk for error and patient harm occurs. To date, all studies conducted on the phenomena of BCMA workarounds are fewer than twelve years old and are primarily explorative in nature. Within the existing literature, the phenomenon has been defined and nurses’ rationales for utilizing BCMA workarounds are clearly described. The types of BCMA workarounds have also been categorized. Existing studies of workarounds have solely focused on the introduction of new HIT. Some of these studies are not specific to BCMA or consider multiple technologies in a
single study. Beyond this basic level of inquiry, no studies exist to further understand BCMA workarounds. In general, a sound methodology to measure workarounds has not been described in the literature. The need to use a rigorous methodology to measure workarounds within the context of safety has been identified by Halbesleben (2010).

When considering the utilization of TAM to understand BCMA workarounds, attention must be given to the concept of user acceptance, also known nurse satisfaction. This concept is defined within TAM and considers the willingness of the individual to use information technology. To understand the acceptance of BCMA by nurses, it is necessary to explore nurses’ perceptions of BCMA usefulness and ease of use and how they may be linked to how satisfied nurses are with BCMA systems. TAM describes user acceptance as being synonymous with user (nurse) satisfaction. It is possible that nurse satisfaction with BCMA could be operationalized through nurses’ perceptions of BCMA usefulness and ease of use. Considering this, it is also possible that a relationship exists between nurse satisfaction with BCMA and the employment of BCMA workarounds. Admitting to utilizing BCMA workarounds is a sensitive matter for nurses and is likely a subject most nurses would not want to talk about since workaround are associated with less than optimal quality of care. If BCMA workarounds are associated with nurse satisfaction of BCMA, evaluating nurse satisfaction with BCMA may be an acceptable measure of workaround usage among nurses. Further exploration of the different types of workarounds is also needed to understand if level of nurse satisfaction with BCMA impacts the type of workaround utilized by nurses, as some workarounds are more dangerous than others, with higher risk workarounds putting patients at greater risk for harm. Workaround usage varies among nurses, indicating the need to better understand
how perceptions of usage and ease of use may impact how often a nurse may choose to
utilize a workaround in lieu of following medication administration policies. To date,
there is no research within the nursing or technology literature which explores these
possibilities. Clearer understanding the relationship between nurse satisfaction with
BCMA and the utilization of workarounds is necessary in order to keep patients safe.
Chapter 3

3.1 Introduction

Chapter 3 describes the methodology for this study. This includes a discussion of the study design, as well as a description of the setting for data collection, and sample of nurses invited to participate in this study. Details of the study instrument are discussed, including instrument adaption and pilot testing. Data collection steps are explained, along with the careful consideration given to ensuring the protection of human subjects. Lastly, this chapter contains a discussion of the data analysis process used in this study.

3.2 Study Design

The purpose of this study was to understand the relationship between registered nurse (RN) satisfaction with their BCMA system, also known as end-user acceptance, RN perceived usefulness (PU), RN perceived ease of use (PEOU) and RN barcode medication administration (BCMA) workaround usage. The Technology Acceptance Model (TAM) was used as a framework to understand the relationship (Alrafi, 2005). This study sought to understand the correlation between study variables; therefore, an analytic, cross-sectional, survey design was used.

Analytic studies are used to evaluate associations, which allows for cause-and-effect inferences to be made about the relationship between the study variables (Hulley, Cummings, Browner, Grady, & Newman, 2007). This design was desirable for this study because it seeks to determine the relationship between the study variables of satisfaction and BCMA workarounds, satisfaction and type of BCMA workaround usage and the relationship among perceived ease of use (PEOU) or perceived usefulness (PU) with satisfaction and BCMA workarounds.
This study was cross-sectional with all data collection completed within a four-week period. Data were collected using surveys that were e-mailed to qualified nurses employed at the study hospital (see Section 3.3 for a description of the study sample). Surveys were chosen as the means to collect data in this study because they are an efficient method to collect data from a large number of participants over a short period of time (Waltz, Strickland, & Lenz, 2010). Surveys are also convenient because they can be administered electronically, therefore allowing data to be collated electronically and scored immediately. Since the surveys were anonymous, no identifying information was collected, providing a secure forum for participants to answer questions honestly. The uniform format of surveys provides for increased reliability, removes the validity threat of interview bias and allows for comparison among respondents (Waltz et al., 2010).

Survey disadvantages may be manifested in low response rates and high missing data rates. Surveys also do not allow for the researcher to clarify items which may be misinterpreted by respondents or to probe for deeper responses. Lastly, surveys may only be administered to literate respondents (Waltz et al., 2010). These advantages and concerns were considered by the researcher and the advantages were determined to outweigh the concerns. Pilot testing of the survey facilitated clarification of item verbiage and surveys was administered only to RNs who are educated individuals, eliminating the concern of illiterate respondents. Careful recruitment strategies were employed to avoid a low response rate and are explained below in the section

*Recruitment of Subjects.*
3.3 Setting and Sample

The setting for this study was a 238-licensed bed, nonacademic teaching hospital/Level II Trauma Center, located in the rural, northeastern United States and designated as a Magnet® hospital in 2008 by the American Nurses Credentialing Center. Limited computerized documentation was introduced in this hospital in 2004, with BCMA and other documentation features added in 2007. Clinical units where BCMA was fully utilized included six medical/surgical units and an intensive care unit (ICU), labor/delivery/recovery/postpartum (LDRP) unit, behavioral health (BH) unit, float pool, dialysis center, and prep and recovery unit (PRU). The patient population in the PRU includes same day surgery patients, inpatients admitted the day of surgery and inpatient post-anesthesia care patients. At the time of this study, BCMA was not yet fully utilized in some of the outpatient areas, such as the emergency department and radiology, and was not available in the operating room.

The target population for this study was acute-care RNs who utilized BCMA during medication administration. Recruitment efforts were focused at one hospital because collecting data from multiple institutions may not provide equal practice environments. If variations among BCMA systems or medication administration policies were great enough, study outcomes could have been impacted. Inclusion criteria for subjects in this study were: 1) being an RN; 2) employed within the research setting for six months or longer at the time of data collection; and 3) working on patient care units where BCMA is fully utilized. There were no restrictions for subjects to participate in this study related to the number of years as an RN or previous experience with technology. Exclusion criteria included: 1) RNs employed at the research setting for fewer than six months; and 2) RNs
employed at the research setting for greater than six months, but in a patient care area where BCMA was not completely utilized or was not utilized at all.

3.3.1. Justification of Sample Size

A convenience sample was utilized for this study because it provided all qualified nurses with the opportunity to participate in the study. Nearly all RNs from qualifying clinical units met study inclusion criteria and none were considered to be more qualified than others within these areas. The use of a convenience sample eliminated the need for the researcher to have personal contact with potential subjects, reducing the chance of researcher influence on a subject’s decision to participate. Convenience samples are beneficial because there is little or low cost involved and subjects are easily accessible; however, a risk exists that nurses responding to the survey may not represent the entire population under study (Hulley et al., 2007).

As of November 2011, approximately 300 nurses were employed within the targeted clinical units, with approximately 265 nurses who meet the study’s inclusion criteria. All qualified nurses were invited to participate in this study in order to maximize the number of surveys returned. With a return rate of 60%, or an effective sample size of 159, a 95% confidence interval has a half width of 5%, conservatively. If the return rate is closer to 30%, or an effective sample size of 79, a 95% confidence interval has a half width of 9.4%, conservatively. Alternatively, an effective sample size of 159 would find a correlation of .16 statistically significant from zero; while an effective sample size of 79 would require a correlation of .22 before it would be statistically significant from zero. In this study, efforts were put forth to obtain at least a 30% response rate.
3.3.2 Recruitment of Subjects

Nurses were recruited from appropriate nursing units at monthly unit council meetings. Clinical units hold two to three meetings per month to provide ample opportunity for RNs on each shift to attend a meeting. The researcher visited at least one of these meetings per unit and explained the study’s purpose, inclusion/exclusion criteria, and how the survey could be accessed (see below, Section 3.5 Procedure of Data Collection). This information was provided in writing to the unit council chairperson to be shared with staff attending the other meetings that the researcher was not able to attend. A flyer with similar information was hung on each unit after the investigator attended the unit council meeting (Appendix A). Qualified nurses were also recruited from the hospital’s shared governance structure meetings. There are six councils within this structure, which meet monthly. The researcher visited each of these six meetings, providing the same information which was provided at the unit council meetings. In addition to these personal visits by the researcher, an email was sent via the hospital email system to RNs on qualified clinical units and inviting them to participate in the study (see Appendix B). Participants could also have been recruited via word of mouth from co-workers.

3.4 Data Collection Instruments

This study used a single survey, the Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN), to measure study variables (Appendix C). The instrument, newly designed by the researcher, consists of items from two pre-established instruments, Hurley’s (2006) Medication Administration System-Nurses Assessment of Satisfaction Scale (MAS-NAS) that measures nurse satisfaction with
BCMA and Halbesleben and Rathert’s (2010) *Workaround Assessment* that measures workaround usage. Since the *MAS-NAS* measures nurse satisfaction with BCMA, it is a measure of user acceptance, as nurses who are satisfied with the BCMA system in their practice environment are more likely to follow designed procedures than those who are not satisfied (Hurley et al., 2006; Hurley et al., 2007). To date, a sound measure of BCMA workarounds has not been established. Existing studies exploring the phenomenon have been qualitative and observational in nature. The instrument used as the basis for measuring workarounds in this study is known as the *Workaround Assessment (WA)* and was developed by Halbesleben and Rathert (2010). The *WA* is intended to measure general process workarounds related to technology usage. Both instruments have been slightly modified by this researcher to be specific to BCMA because in their original states, they were general. The *MAS-NAS* refers to the general medication administration process and was originally used to measure nurse satisfaction with medication administration systems both pre- and post-BCMA implementation. Language within the instrument refers to the current medication administration system that a nurse is using at the time of survey completion (which may not be a BCMA system), so questions which were too vague were reworded to be BCMA specific. The *WA* was written to measure any type of technology workaround, which may have included BCMA, but was not specific to this technology. Since this study sought to specifically measure BCMA workaround usage, the items within this instrument were also reworded to be specific to BCMA and eliminate possible confusion to research subjects. Permission was received from both Hurley and Halbesleben to use and modify these instruments for this study (Appendix D).
In order to understand the *WUSBIN*, it is necessary to first describe the two instruments in their original states, the *MAS-NAS* and the *WA*, which were slightly modified to create the final study instrument. This discussion is followed by a description of the modifications made to the *MAS-NAS* and *WA*, followed by a detailed description of the *WUSBIN*.

### 3.4.1. The Medication Administration System-Nurses Assessment of Satisfaction Scale (*MAS-NAS*)

The *MAS-NAS* is an instrument which “enables identification of potential problem areas and comparison before and after implementation of barcode/eMAR technology” (Hurley et al., 2006, p. 298). Its purpose is to provide hospital leaders with a forum to understand nurse satisfaction with BCMA and the electronic medication administration record (eMAR) (Hurley et al., 2006). Data collected from this instrument can be used to understand nurse satisfaction before and/or after BCMA/eMAR technology implementation because it provides nurses with an opportunity to rate their satisfaction with the current medication administration system. Evaluation of these data portrays nurses’ opinions with the BCMA system for consideration by the nurse leaders of their institution. Since the study hospital has already implemented BCMA, only post-implementation satisfaction will be measured.

The *MAS-NAS* consists of 18-items pertaining to “support for team communication, efficient use of time, ease of carrying out the five rights of medication administration, support for the application of clinical judgment and straightforward, real-time documentation” (Hurley et al., 2006, p. 298). These items are organized among three factorially derived subscales known as: 1) Efficacy: dependable and effective systems
(survey items 10, 12-15); 2) Safety: system component assures nurse that it is correct to administer the medication (survey items 2-5, 8,11); and 3) Access: having necessary information and medications immediately at hand (survey items 1,6,7,9,16) (Hurley et al., 2006; Hurley et al., 2007). A 6-point Likert-type scale provides response options for the survey items from ‘strongly agree’ (score = 1) to ‘strongly disagree’ (score = 6) and an option for ‘not applicable’. Two open-ended questions prompt respondents to comment on any component of the current system and to offer suggestions for improvement. Respondents are then asked to rate their overall satisfaction with the current system utilizing a 1 to 10 visual analogue scale, with 1 indicating “complete dissatisfaction” and 10 indicating “complete satisfaction” with the current medication administration system. Lastly, respondents are prompted to answer 13 open and close-ended demographic questions about their age, gender, employment status (full time, part time or per diem) and history (years working as an RN and years working as a RN at the study hospital), computer usage and skill.

Reliability of the MAS-NAS was determined during instrument development by the creator, Dr. Ann Hurley, Brigham and Women’s Hospital and Northeastern University, Boston, MA, utilizing experts to design questions, end-users to confirm item content and clarity of instructions, as well as test/retesting of the instrument. The survey items had total correlations greater than .03 and less than .07. Alpha coefficients ranged from 0.75-0.85 for the subscales described above and was 0.91 for the entire scale (Hurley et al., 2007).

Validity was determined by factor analysis with varimax rotation and Kaiser normalization, indicating a three-factor solution (Hurley et al., 2006). Three factors
(efficacy, safety and access), were used to determine the subscales previously described regarding instrument development. The subscales had high statistically significant positive Pearson correlations and low statistically non-significant paired $t$-tests (Hurley et al., 2006). Instrument developers controlled for type I alpha error by using Bonferroni correction, which was used to make the $P$ value for statistical significance equal to 0.125. This ensured that the total type I error for all analyses did not exceed 5% (Hurley et al., 2007).

3.4.2 Workaround Assessment (WA)

The WA, developed by Halbesleben and Rathert (2010), is intended to measure healthcare workers’ use of technology related workarounds. It was developed because a valid measure of workarounds did not exist (Halbesleben & Rathert, 2010). The instrument has 22 items, grouped into four subscales: 1) perception of block (items 1-5); 2) altering process to work around a block (items 6-10); 3) preference for following procedures (items 11-17); and 4) motive to assist patient (items 18-22). These subscales are based on the proposed thought processes underlying workarounds and categories of workarounds found in the literature. Proposed thought processes include perception of a block, altering processes to work around blocks, preferences for following procedures, and motive to assist patients. The context of workarounds in the literature was summarized as blocks related to technology, rules/policies, other people/coworkers, equipment and poorly designed work processes. Survey items were created by crossing identified thought processes with the context of the workarounds (Halbesleben & Rathert, 2010). A 6 point Likert-type scale is used to answer each survey item, with a rating of 1 indicating “strongly disagree” and 6 indicating “strongly agree”.
Validity and reliability of this measure were established through a survey design study, inviting 14,065 nurses in the state of Minnesota to complete the instrument items (Halbesleben & Rathert, 2010). Test-retest reliability was established by repeating the process once a week for three weeks. Data were matched for 460 nurses over the three week study, resulting in positive and significant correlations. Significant correlations were found in the first week’s workaround scores and both week two \((r = .39, p < .05)\) and week three \((r = .21, p < .05)\). Significant correlations were also noted in week two and week three scores \((r = .26, p < .05)\) (Halbesleben & Rathert, 2010). Lower correlation scores are expected when measuring a behavior such as workarounds because the usage of workarounds has a high variability from nurse to nurse and even from shift to shift or patient to patient for the same nurse, as different situations present different opportunities to utilize workarounds. While the correlations found here were not high, they were still found to be statistically significant and are therefore considered to be meaningful.

In order to test the construct validity of the measure, established measures of deviance and job crafting were added to the study survey (Halbesleben & Rathert, 2010). The authors measured deviance using an instrument of workplace deviance developed by Mitchell and Ambrose (2007) and job crafting, using an instrument of Timms, Bakker and Derks (2009) (Halbesleben & Rathert, 2010).

Factor validity was tested using a multi-trait, multi-method framework (Halbesleben & Rathert, 2010). Comparing the scores for deviance and job crafting provided additional construct validity. While there were positive correlations between the scores for deviance and job crafting, they were not found be significant \((r = .045)\). A negative
A correlation between workarounds and deviance was found to be significant ($r = -.10, p < .05$) (Halbesleben & Rathert, 2010).

3.4.3 Study survey development

A single instrument, named the Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN), was developed by this study’s researcher by integrating all survey items from the MAS-NAS and WA in order to make a direct comparison between nurse satisfaction with BCMA and BCMA workaround usage. The original forms of the MAS-NAS and WA are not BCMA specific, requiring modification to some of the items from both surveys to include BCMA verbiage. A description of MAS-NAS and WA modifications is provided in the following section, followed by a detailed description of the WUSBIN development.

The Medication Administration System-Nurses Assessment of Satisfaction Scale (MAS-NAS) Modifications

The MAS-NAS was modified by the researcher under the guidance of Halbesleben and based on his experience with its use (Halbesleben, 2010; Halbesleben & Rathert, 2010). Five of the 18 items (items 10, 11, 13, 14, 15) in this instrument were modified so that their verbiage directly addressed BCMA in the statement. The remaining 11 items were found be sufficient as written. Two items were added to the survey in order to obtain information about nurses’ access to assistance for broken scanners and nurse apprehension with the barcoding system. It was also necessary to modify the question which utilizes a visual analogue scale by asking subjects to choose the number which most closely correlates with their overall satisfaction with the BCMA system utilizing a
1-10. On this scale, the score of 1 indicates completed dissatisfied, 5 indicates neither satisfied or dissatisfied and 10 indicates completely satisfied. This modification was necessary because the survey will be administered electronically and not on paper, and it is not possible to mark a visual analogue scale using the electronic format. Demographic questions were modified to substitute the name of the study hospital for the name of the original hospital where the instrument was developed. In addition, one item which asked respondents to supply the number of hours worked per week was replaced with an item simply asking employment status, with choices of full time, part time and per diem, as this information is more useful than actual number of hours worked.

**Workaround Assessment (WA) Modifications**

The WA was also modified, under the guidance of Halbesleben, to focus specifically on BCMA workarounds. The original 22 items were revised to be specific to BCMA workarounds and a fifth subscale, consisting of six items, was added to measure the Technology Acceptance Model (TAM) concept of Computer Anxiety. The existing four subscales already measured the TAMs anchor beliefs of control and intrinsic motivation; however, a measure of emotion, or computer anxiety, needed to be added. The modified version of the WA consists of 28 items.

**Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN)**

**Overview**

The WUSBIN consists of three parts and 62 items (Appendix B). Part I measures nurse satisfaction with BCMA and nurse perceptions of workaround usage (items 1 - 49).
Part II measures the type of workarounds used by study participants (items 50 - 51). Part III measures survey participant demographic information (items 52-63). Table 3.1 provides a summary of the WUSBIN by describing which study variable are measured in each part of the survey and which subscales and survey items provide the variable measurement.
### Table 3.1

**Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN)**

**Overview**

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<thead>
<tr>
<th>Survey Part</th>
<th>Variables</th>
<th>Subscales with Item Numbers</th>
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<tbody>
<tr>
<td>Part I</td>
<td>Satisfaction</td>
<td>Overall Satisfaction with BCMA (item 1)</td>
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<tr>
<td></td>
<td></td>
<td>Nursing Satisfaction Subscale: Efficiency (items 2-6)</td>
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<td>Nursing Satisfaction Subscale: Safety (items 7-13)</td>
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<td>Nursing Satisfaction Subscale: Access (items 14-19)</td>
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<td>PEOU</td>
<td>Workaround Subscale: Block Perceptions (items 20-24)</td>
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<td>Workaround Subscale: Altering Processes (items 25-29)</td>
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<td>Workaround Subscale: Procedural Preferences (items 30-36)</td>
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<td>Workaround Subscale: Computer Anxiety (items 42-47)</td>
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</tr>
<tr>
<td>Part III</td>
<td>Demographics</td>
<td>Items 52-63 (no subscale)</td>
</tr>
</tbody>
</table>

*Note. PEOU = Perceived Ease of Use; PU = Perceived Usefulness; BCMA = Barcode Medication Administration.*

Part I of this survey is the longest section of the survey, consisting of items 1-49. The first item in Part I (item 1) asks the respondent to rate their overall satisfaction with the
BCMA system on a 1-10 scale, with 1 indicating “complete dissatisfaction” and 10 indicating “complete satisfaction”. Items 2-47 are statements referring to the current medication administration system used by the nurse. Respondents are asked to rate their degree of agreement with each statement using a 6-point Likert Scale, with 1 indicating “strong agreement” with the statement and 6 indicating “strong disagreement” with the statement. There is a seventh option, “not applicable”, for when a statement does not apply to the subject’s practice. Items 2-19 measure nurse satisfaction with their current BCMA system and is broken down into three subscales. Items 20-47 measure nurse workarounds with BCMA and are broken down into five subscales. Further discussion of the subscales follows the description of the survey overview. Items 48-49 are multiple-choice, measuring workaround usage by nurses. According to Koppel (2008), 15 different types of BCMA workarounds exist. Of these 15 types, 13 are possibilities within the BCMA system at the study setting. Nurses completing the survey will be asked to identify which of the 13 BCMA workarounds they have utilized (item 48) and to identify which single BCMA workaround they utilized the most (item 49).

Part II of this survey contains two items (items 50-51) which gives nurses the opportunity to provide their opinion of the BCMA system and what they would change within the system if they could. These questions are open-ended and do not require a response, meaning that the subject can leave the fields blank if they do not have any comments.

Part III of this survey consists of 12 demographic items (items 52-63) that are consistent with 12 of the 13 items used in the MAS-NAS. The item inquiring about current position was eliminated from the WUSBIN because only staff nurses will be
administered the survey, which negates the need to collect this data. All 12 items use multiple choice options aimed to increase subject anonymity and to avoid accidental identification of a subject based on a response provided. Demographic items include information such as age, gender, level of nursing education, nursing experience, unit type (inpatient/outpatient) details of current employment and experience with computers and with barcoding.

**WUSBIN Subscales Description**

Part I of the WUSBIN is made up of nine subscales. Item 1 is the first item in Part I and measures overall nurse satisfaction with the BCMA system. It is not part of a subscale. The first three subscales measure nurse satisfaction with the BCMA system and 16 of these 18 items are consistent with the three subscales from the MAS-NAS (Hurley et al., 2007): 1) Nursing Satisfaction Subscale: Efficiency (items 2-6); 2) Nursing Satisfaction Subscale: Safety (items 7-13); and 3) Nursing Satisfaction Subscale: Access (items 14-19). *Efficiency* refers to how dependable and efficient the system is, while *safety* assures the nurse that it is safe to proceed with the medication administration and *access* ensures the nurse has the required medications and information (Hurley et al., 2006). As mentioned in the discussion regarding the MAS-NAS modifications, two items were added to the survey in order to obtain information about access to assistance for broken scanners (item 19) and apprehension with the barcoding system (item 13).

The next five subscales measure BCMA workaround usage by nurses and are consistent with the variables in the TAM (Dillion & Morris, 1996): 1) Workaround Subscale: Block Perceptions (items 20-24); 2) Workaround Subscale: Altering Processes
(items 25-29); 3) Workaround Subscale: Procedural Preferences (items 30-36); 4) Workaround Subscale: Motive to Assist Patients (items 37-41) and 5) Workaround Subscale: Computer Anxiety (items 42-47). The Workaround Subscale: Block Perceptions measure nurse perceptions of blocks, which identifies with the variable *Perceived Ease of Use (PEOU)*, particularly the belief anchored in external control because these items measure perceptions of technology resources. The Workaround Subscale: Altering Processes measures modifying processes to workaround blocks, linking them to *PEOU* through the anchor belief of internal control, or the users’ perceptions of self-efficacy related to using BCMA. Workaround Subscale: Procedural Preferences measure nurse preferences for following procedure, specifically the hospital’s BCMA procedure. Within the TAM framework, *PEOU* is anchored in the belief of intrinsic motivation, or the nurse’s perceptions of pleasure and satisfaction from BCMA. Workaround Subscale: Motive to Assist Patients is related to the nurses’ motivation to assist patients and measures how useful nurses perceive the system to be in order to provide care. This subscale is consistent with the variable of *perceived usefulness (PU)*. The Workaround Subscale: Computer Anxiety, is anchored in emotion, or the negative affective reaction of computer anxiety, which is consistent with the variable *PEOU*.

The last subscale in Part I is the Workaround Subscale: Workaround Types. This subscale consists of items 48-49 and measures the types of workarounds utilized by nurses. Table 3.2 summarizes the *WUSBIN* subscales.
**Table 3.2**

**Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN)**

**Subscale Summary**

<table>
<thead>
<tr>
<th>Study Variable</th>
<th>Survey Items</th>
<th>Subscale Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA Satisfaction</td>
<td>2-6</td>
<td>Nurse Satisfaction Subscale: Efficiency</td>
</tr>
<tr>
<td></td>
<td>7-13</td>
<td>Nurse Satisfaction Subscale: Safety</td>
</tr>
<tr>
<td></td>
<td>14-19</td>
<td>Nurse Satisfaction Subscale: Access</td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>20-24</td>
<td>Workaround Subscale: Block Perceptions&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>25-29</td>
<td>Workaround Subscale: Altering Process&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>30-36</td>
<td>Workaround Subscale: Procedural Preference&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>37-41</td>
<td>Workaround Subscale: Motive to Assist the Patient&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>42-47</td>
<td>Workaround Subscale: Computer Anxiety&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>48-49</td>
<td>Workaround Subscale: Workaround Types</td>
</tr>
</tbody>
</table>

*Note.* BCMA = barcode medication administration.  <sup>a</sup>indicates Perceived Ease of Use (PEOU) measures.  <sup>b</sup>indicates Perceived Usefulness (PU) measures.

**Scoring the WUSBIN**

Scores of interest from the *WUSBIN* include: 1) **BCMA Satisfaction**; 2) **Workaround Usage**; 3) Frequency of reported workarounds; 4) **PEOU**; 5) **PU**; and 6) Most common workaround used. Table 3.3 below summarizes the subscale scoring. Calculation of each of these scores is provided in the following section.

The **BCMA Satisfaction** score indicates the level of RN satisfaction with the BCMA system. This score is determined by calculating the sum of items 2-19. In its original format, the Likert-type scale utilized in the **BCMA Satisfaction** subscale is set
up so low choices indicate high levels of satisfaction; therefore, when a total score is calculated for this subscale, low score indicates high satisfaction. In an attempt to keep the scoring process from becoming confusing in this study, at the time of scoring the WUSBIN, subject responses were reversed so that high scores indicated high satisfaction. This means a minimum score of 18 indicates the lowest level of RN satisfaction with the BCMA system and a maximum score of 108 indicates the highest level of RN satisfaction with the BCMA system. Separate from this score is how nurses rate their overall satisfaction with the BCMA system (item 1). An average score will be calculated from these ratings to determine how satisfied the population is with the current BCMA system.

Workaround Usage considers how likely a nurse is to use a workaround in practice and is calculated by the summing items 20-47. Like the satisfaction items above, a low score on this subscale indicated a high workaround usage. For consistency sake, items in this subscale were also reverse-scored so low scores indicating low workaround usage and high scores indicating high workaround usage. An exception is items 30-36 where a low score already indicates low workaround usage and a high score indicates high workaround usage. This scale was also reverse scored at the time of data analysis so that scores correctly reflected the workaround practices of the subject. A maximum workaround score of 143 indicates the greatest workaround usage score possible a minimum score of 53 indicates the lowest workaround usage score possible.

Frequency of Workarounds Used indicates common workarounds that are often utilized by nurses. This is determined in items 48 and 49. Item 48 simply identifies which of 13 common workarounds are utilized by study subjects. The frequency of
usage for a particular workaround can be determined here. Item 49 specifically asks study subjects to indicate which of the same common 13 workarounds (identified in item 48) they use the most often. A frequency count to determine the most common BCMA workaround type will be calculated.

Table 3.3

*Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN)*

*Subscale Scoring Summary*

<table>
<thead>
<tr>
<th>Variable with Item Number</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BCMA Satisfaction</strong></td>
<td>18-108</td>
</tr>
<tr>
<td>(Items 2-19)</td>
<td></td>
</tr>
<tr>
<td><strong>Workaround Usage</strong></td>
<td>53-143</td>
</tr>
<tr>
<td>(Items 20-47)</td>
<td></td>
</tr>
<tr>
<td><strong>PEOU</strong></td>
<td>23-138</td>
</tr>
<tr>
<td>(Items 20-36; 42-47)</td>
<td></td>
</tr>
<tr>
<td><strong>PU</strong></td>
<td>5-30</td>
</tr>
<tr>
<td>(Items 37-41)</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* BCMA = Barcode Medication PEOU = Perceived Ease of Use; PU = Perceived Usefulness;

Consistent with the TAM, the variables of PEOU and PU are measured within the WUSBIN. Scores indicating nurse perception of BCMA ease of use (PEOU) are calculated summing survey items 20-36 with items 42-47. A maximum PEOU score of 138 indicates the lowest perception of ease of use for the BCMA system, while a minimum score of 48 indicates the highest perception of ease of use of the BCMA system. Scores indicating nurse perceptions of BCMA usefulness (PU) are calculated by
summing survey items 37-41. This score is equal to the Workaround Usage subscale, Motive to Assist Patients. A maximum \( PU \) score of 30 indicates the lowest perception of usefulness of the BMCA system and a minimum score of 5 indicates the highest perception of usefulness of the BCMA system.

Items 50-51 are optional open-ended questions, inviting study subjects to comment on any aspect of the BCMA system which support their ability to administer medications and to describe any one aspect of the BCMA system they would change if they could. Responses to these items are categorized into similar themes and reported as a simple content analysis. A concept analysis is performed of these two items, as responses to these items are not the main focus of this study.

*Administration of the WUSBIN*

*Survey Monkey*, a web-based commercial survey program, was the main method utilized to administer this survey (http://www.Survey monkey.com). An electronic administration of the *WUSBIN* was desired for this study for a variety of reasons. First, electronic administration allowed all eligible subjects to be simultaneously contacted and invited to participate. This approach ensured that all eligible subjects had equal time to consider survey participation and had equal access to the survey. Second, *Survey Monkey* collected and scored all study data and automatically entered it into a data collection spread sheet, eliminating the risk of hand scoring and manual transcription of data into a spreadsheet. Additional benefits of electronic administration of surveys included the following: eliminating the risk of losing/misplacing surveys; the choice of completing the survey at work or at home, at their convenience, or without the concern how they will
return the survey to the researcher; faster survey completion time for participants; increased participant anonymity and sense of control; and risk of participants providing socially desirable responses (Balajti, Darago, Adany, & Kosa, 2010; Cantrell & Lupinacci, 2007; Strickland et al., 2003; Waltz, Strickland, & Lenz, 2010). Concerns considered with electronic survey administration included the risk of subjects misunderstanding how to access or complete the electronic survey, subjects experiencing technical difficulties when attempting to complete/submit their survey, and multiple survey submissions by an individual. A noted observation among studies conducted using on-line data collection was that, in general, those people who participate in on-line surveys may differ from the general population because not all people have internet access or are computer savvy, discouraging these people from completing an electronic survey (Balajti et al., 2010; Cantrell & Lupinacci, 2007; Strickland et al., 2003; Waltz et al., 2010). In order to reduce issues related to accessing the survey, the study invitation was emailed to potential subjects with a direct link to the WUSBIN. The survey provided detailed instructions describing how to utilize the site in order to complete the survey. All invited participants had access to the internet and to reliable computer usage at work, where they could complete the survey if they wished. It was not possible to control for individual attitudes or feelings towards computers, factors that may have discouraged their survey participation.

It is possible that some potential study participants were not comfortable with completing the survey electronically (Tremblay, 2010). For this reason, a paper version of the survey was offered to the study population at the midpoint of the study’s administration period. In addition, to ensure participant comfort, surveys which have
been conducted with both electronic and paper/pencil format options have higher response rates that studies that used electronic or paper/pencil surveys alone (Balajti et al., 2010). In a study of college students who were offered the opportunity to complete a survey either electronically or with paper/pencil (n=1,008), a 65.2% response rate was achieved, with 58.8% of the respondents completing electronic surveys and 41.2% completing paper/pencil surveys (Balajti et al., 2010).

Since no subject identifiers were collected in this study and because the study was available both electronically and on paper, the researcher did not know if a nurse accessed or completed the survey more than once; therefore, the detailed instructions informed subjects that they should participate only once in order to ensure that data were not skewed by multiple submissions by one subject.

Testing to determine how much time was needed to complete the survey occurred during the pilot study (see next section below). The survey could be accessed from any hospital or personal computer that had internet access. Nurses could complete the survey either on a hospital computer or outside the hospital using a computer or smart phone with internet access.

3.5 Procedure for Data Collection

3.5.1. Pilot Study

A pilot study was conducted to test the *WUSBIN* for appropriate verbiage content and process feasibility. Testing outcomes resulted in survey improvements which served to maximize the response rate of the survey. Reliability and validity of the instruments from which the *WUSBIN* were derived, the *MAS-NAS* (Hurley et al., 2007) and *WA*
(Halbesleben & Rathert, 2010), have already been established; therefore, this pilot did not seek to reestablish this. The pilot study objectives included:

1. To trial the survey’s verbiage for understandability;

2. To trial administration of the WUSBIN electronically via Survey Monkey and on paper;

3. To determine survey completion time

The same subject inclusion and exclusion criteria from the main study applied in the pilot study that was conducted in the same setting where the primary study data were collected. Recruitment was limited to a small group of RNs who were representative of the target population. It was necessary to ensure that a nurse with at least one of the following characteristics was represented within the pilot study population: 1) hired before April 2008, when the BCMA system was implemented; 2) hired after April 2008; 3) greater than 45 years of age, the mean age of nurses at the study hospital; 4) less than 45 year of age; 5) works on an inpatient unit; 6) works on an outpatient unit; 7) female; 8) male; 9) one nurse each with an Associate’s Degree in Nursing (ADN), Diploma in Nursing (DIP) and Bachelor of Science Degree in Nursing (BSN); 10) rotates shifts; 11) does not rotate shifts; 12) works full time; and 13) works part time or per diem. It was assumed that all nurses in the pilot study worked on a clinical unit where BCMA was practiced, and that one nurse represented more than one desired characteristic. For example, a female nurse from an inpatient area may have possessed an ADN and was older than 45 years of age. It was estimated that ten nurses were needed to participate in
the pilot study. Once all sample characteristics were represented at least once, the pilot study was considered completed.

A pilot test of this nature was desired for this study because the number of nurses who qualified for the main study was 265; therefore, obtaining a large sample size for either the pilot or for the main study was not reasonable. Pilot data collected were discarded before the main study began, which permitted pilot study subjects to participate in the main study, if they desired. Human subject approval for the pilot study was obtained at the same time as the main study from the Institutional Review Boards from both Duquesne University and the study hospital (Appendix E). See Section 3.5.3 in this chapter for details related to the protection of human subjects in the main study, as the same information was applicable to the pilot study.

Since pilot study subjects were verbally invited to participate by the researcher, they qualified as a convenience sample. Written consent was obtained from each participant, since they were hand chosen by the researcher (Appendix F). Written consent was not obtained for participation in the main study. A verbal walk through, or usability testing methodology, was used where subjects were encouraged to talk out loud, express their thoughts and questions while they answered each item as the researcher listened and took notes. Pilot participants were given the option of completing the WUSBIN electronically or by paper (see the next section for more details). It was especially important to trial the on-line surveys before beginning data collection for the primary study in order to obtain feedback regarding challenges encountered and benefits noted with the electronic format (Strickland et al., 2003). Both the MAS-N4S (Hurley et al., 2007) and WA (Halbesleben & Rathert, 2010) have been administered electronically
and on paper in their original formats (Halbesleben & Rathert, 2010; Hurley et al., 2007; Tremblay, 2010). Each participant was timed while they completed the pilot study to determine an average completion time for the primary study. Utilization of the usability testing methodology met the objectives of the pilot study.

3.5.2. Primary Study

Data collection for this study was conducted from December 21, 2011 until January 22, 2012. Registered Nurses from the study hospital who met the inclusion criteria were recruited to participate in the primary study using a variety of strategies: emails sent by the researcher using the nurses’ hospital email accounts (Appendix B); flyers posted in nurse break and locker rooms (Appendix A); announcements made by the researcher at unit and hospital council meetings; and by word of mouth. The recruitment email that was sent to the nurses contained a link to the WUSBIN via Survey Monkey (http://www.survey monkey.com). The first screen provided subjects with a copy of the study letter (Appendix C) that was used in lieu of a signed consent form. The letter served as informed consent and described the study purpose, risks and benefits, and informed subjects that they had the option to change their minds about participating at any time during the study. The second screen provided survey instructions (Appendix C), followed by the beginning of the survey. After subjects completed the survey, a screen appeared that thanked them for their participation. Subject identification was not tracked during the survey process. The survey link was available for a 4-week period, as this is the recommended length of time for online surveys (Cantrell & Lupinacci, 2007). A reminder e-mail, including a study link, was sent to qualifying nurses at the two and
three week points to remind them about the survey because responses at those times were less than desirable (Appendix G).

In order to accommodate nurses who were interested in completing the WUSBIN but were not comfortable completing the survey electronically and to boost survey response rates, a paper version of the survey was distributed at the midpoint of the data collection. The paper versions were distributed on nursing units where nurses who met the study’s inclusion criteria worked. Paper versions of the study had an attached, pre-addressed envelope so that completed surveys could be returned to the primary investigator via interoffice mail. For the purpose of convenience, paper surveys and envelopes were also distributed at the hospital’s Shared Governance Council Day.

3.5.3 Protection of Human Subjects

This study was considered minimal risk as there was no intervention. No personal identifiers were collected, nor could the researcher to make a connection between the survey link the subject’s e-mail account. This approach made it impossible for the researcher to track whether a nurse chose to complete or not complete the survey. Demographic responses were multiple choice options provided using a range format to prevent identifying subjects with unique characteristics. For example, responses to demographic items such as age, years of experience as a nurse, and years at the study hospital were offered as a range of years. The only participants who were identified were those nurses who participated in the pilot study because a verbal walk through methodology with the researcher was utilized. All pilot data were discarded and not analyzed or used in the primary study.
Due to the low risk nature of this study, it approved through an expedited review by Institutional Review Boards (IRBs) at both Duquesne University and the Guthrie Healthcare System. IRB approvals were obtained for both the pilot and main study (See Appendix E)

3.6. Data Analysis

The analysis for this study was quantitative in nature. The analysis program used to conduct the data analysis was SPSS, 20.0 graduate version. Before data analysis began, each survey was reviewed for completeness. It was determined that any survey with more than 5 items left blank (10%) in Part I blank would be considered “incomplete’ and would not be used in the data analysis. However, survey items 50 and 51 were asked for open-ended comments and were considered optional, as were items 52-63, which asked for demographic information. These items were intentionally not taken into account when reviewing surveys for completeness. This decision was made to eliminate an inaccurate analysis due to missing data, which could skew survey outcomes.

Descriptive statistics were used to depict the demographic data: age; highest degree earned; number of years in nursing, both in general and at the study hospital; scheduling details; computer usage and experience with computers. In addition, a correlational matrix was generated to determine whether any two variables co-varied and thus, treated as confounding variables in this study. While research questions were answered utilizing multiple analytical tests, all statistical tests were performed at the 5% (α=0.05) level of significance. Individual research questions were analyzed as follows:

Question 1. What is the relationship between registered nurse (RN) satisfaction with barcode medication administration (BCMA) and their workaround usage?
H₀: There is no relationship between registered nurse (RN) satisfaction with barcode medication administration (BCMA) and their use of workarounds.

Hₐ: There is a negative correlation between registered nurse (RN) satisfaction with barcode medication administration (BCMA) and their workaround usage.

Analysis method: Both variables in this research question are interval scale measures, requiring the use of the Pearson’s Correlation Coefficient ($r^2$) to determine the relationship.

Question 2. Does BCMA satisfaction affect perceptions of ease of use (PEOU) of BCMA, perceptions of usefulness (PU) of BCMA and workarounds used, as measured by the WUSBIN?

H₀: There is no relationship between BCMA satisfaction and perceptions of ease of use (PEOU) of BCMA or perceptions of usefulness (PU) of BCMA, as measured by the WUSBIN.

Hₐ: There is a negative correlation between BCMA satisfaction and perceptions of ease of use (PEOU) of BCMA and between perceptions of usefulness (PU) of BCMA, as measured by the WUSBIN.

Analysis method: The variables in this research question are interval scale measures, requiring the use of the Pearson’s Correlation Coefficient ($r^2$) to determine the relationship.

H₀: There is no relationship between BCMA satisfaction and the type of workarounds used, as measured by the WUSBIN.
Hₐ: There is a relationship between BCMA *satisfaction* and the type of workarounds used, as measured by the *WUSBIN*.

This relationship was determined using *WUSBIN* survey items 48. This item measures which workarounds nurses use, regardless of frequency. For the purpose of conducting a proper analysis, *BCMA satisfaction* was tested against use or non-use of each of the 13 workaround types in the *WUSBIN*, survey item 48. A sample is provided in the following section to illustrate a specific hypothesis generated from this research question, as all 13 hypotheses are not written at this time. This sample utilizes item 48, choice A, as the independent variable.

H₀: There is no relationship between level of *BCMA satisfaction* and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the *WUSBIN*.

Hₐ: There is a relationship between level of *BCMA satisfaction* and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the *WUSBIN*.

Analysis method: Treating *BCMA satisfaction* as the dependent variable, and each of the types of workaround as an independent variable with two levels (used or not used), the independent t-test was used to see whether each type of workaround was related to the *BCMA satisfaction*. This
approach was used for all 13 hypotheses generated from this research question.

H₀: There is no relationship between BCMA satisfaction and the number of workarounds used, as measured by the WUSBIN.

H₁: There is a relationship between BCMA satisfaction and the number of workarounds used, as measured by the WUSBIN.

Analysis method: The number of workarounds used was determined by counting the number workarounds identified in the WUSBIN, survey item 48. Since both variables in this research question are interval scale measures, the use of the Pearson’s Correlation Coefficient ($r^2$) to determine the relationship was required.

H₀: There is no relationship between BCMA satisfaction and the number of workarounds used, as measured by the WUSBIN.

H₁: There is a relationship between BCMA satisfaction and the number of workarounds used, as measured by the WUSBIN.

H₀: There is no relationship between BCMA satisfaction and the workaround used most often, as measured by the WUSBIN.

Question 3. Does workaround usage affect PEOU of BCMA, PU of BCMA and workaround used, as measured by the WUSBIN?

H₀: There is no relationship between workaround usage and perceptions of ease of use (PEOU) of BCMA or perceptions of usefulness (PU) of BCMA, as measured by the WUSBIN.
Hₐ: There is a positive correlation between Workaround Usage and perceptions of ease of use (PEOU) of BCMA perceptions of usefulness (PU) of BCMA, as measured by the WUSBIN.

Analysis method: The variables in this research question are interval scale measures, requiring the use of the Pearson’s Correlation Coefficient ($r^2$) to determine the relationship

H₀: There is no relationship between Workaround Usage and the type of workarounds used, as measured by the WUSBIN.

Hₐ: There is a relationship between Workaround Usage and the type of workarounds used, as measured by the WUSBIN.

This relationship was determined by using WUSBIN survey item 48. This item measures which workarounds nurses use, regardless of frequency. For the purpose of conducting a proper analysis, workaround usage was compared to the frequency of each of the 13 workaround types in item 48, resulting in 26 different hypotheses. Provided here is a sample of the hypotheses generated from this research question, as all 26 hypotheses are not written here. This sample utilizes item 48, choice A, as the independent variable.

H₀: There is no relationship between level of Workaround Usage and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the WUSBIN.
Hₐ: There is a relationship between level of *Workaround Usage* and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the *WUSBIN*.

Analysis method: Treating *workaround usage* as the dependent variable, and each of the types of workaround as an independent variable with two levels (used or not used), the independent t-test was used to see whether each type of workaround is related to the BCMA satisfaction. This approach was used for all 13 hypotheses generated from this research question.

**Question 4.** What is the relationship between levels of *BCMA satisfaction* and the *workaround usage* with the demographic variables of: 1) gender; 2) age; 3) highest nursing degree earned; 4) number of years employed as an RN; 5) number of years employed as an RN at the study hospital; 6) unit type; 7) shift worked; 8) schedule worked; 9) self-rated computer skills; 10) presence of computer at home and; 11) self-rated skill of obtaining patient information from the study hospital computer system?

This question was answered using Part III of the *WUSBIN*, survey items 52 through 63. For the purpose of conducting a proper analysis, the dependent variables of *BCMA satisfaction* and *workaround usage* were compared to all 12 of the demographic items (independent variables), resulting in 24 different hypotheses. Provided here is a sample of the
hypotheses generated from this research question, as all 24 hypotheses are not written here. This sample utilizes item 52.

\( H_0: \) There is no relationship between level of BCMA satisfaction and each demographic variable measured by the WUSBIN.

\( H_1: \) There is a relationship between level of BCMA satisfaction and each demographic variable measured by the WUSBIN.

Analysis method: In this hypothesis, the dependent variables are interval scale measures, and the independent variables are categorical. An ANOVA F-test was used to test significance of the independent variables with the dependent variable of BCMA satisfaction. This test was used for all 24 hypotheses generated from this research question.

3.7. Summary

This study utilized an analytic, cross-sectional, survey design to answer the research questions. Questions were measured using the WUSBIN, an instrument developed by modifying and combining two existing instruments which measure BCMA satisfaction and workaround usage. A pilot study was necessary to establish usability of the instrument. Data analysis considered the use of Pearson product moment correlation coefficient, independent t-test, ANOVA, descriptive statistics and content analysis.
Chapter 4

4.1 Introduction

This study examined the relationship between nurse satisfaction with barcode medication administration (BCMA) and workaround usage. This chapter describes the statistical analysis of the study data. A discussion of the pilot study, how this process ensured that the *Workaround Usage and Satisfaction with Barcoding Instrument for Nurses* (*WUSBIN*) was suitable for use, and the pilot outcomes begins the chapter. A description of the main study follows, beginning with a description of the study sample. Data collection steps are then described, followed by the study findings for each of the four study questions, along with an exploratory analysis of the data generated by each.

4.2 Pilot Study

4.2.1 Pilot Study Description

Before the *WUSBIN* could be administered to nurses, it was necessary to calculate the survey administration time, in order to ensure that the language was understandable by the intended audience and that the tool was user-friendly. Pilot subjects (N=9) met all study inclusion criteria (Chapter 3.3) and were hand-selected by the researcher to ensure that all study population characteristics were represented at least once (Chapter 3.5.1). Characteristics such as working at the hospital before BCMA implementation (n=6, 66.7%), female gender (n=7, 77.8%), working fulltime (n=7, 77.8%) and working in an inpatient area (n=7, 77.8%) were met by at least half or more of the pilot study subjects, while characteristics such as age fewer than 45 years (n=4, 44.4%) and type of nursing educational background (associate’s degree (n=1, 11.1%), diploma (n=2, 22.2%), bachelor’s degree (n=4, 44.4%) and master’s degree (n=2, 22.2%) represented less than
half of the pilot subjects. See Table 4.1 for a description of pilot study subjects’ characteristics.

Table 4.1

*Pilot Study Sample Description (N=9)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worked at study hospital before BCAM implemented</td>
<td>6</td>
<td>66.7%</td>
</tr>
<tr>
<td>&lt; 45 years old</td>
<td>4</td>
<td>44.4%</td>
</tr>
<tr>
<td>Nurses working in inpatient area</td>
<td>7</td>
<td>77.8%</td>
</tr>
<tr>
<td>Female gender</td>
<td>7</td>
<td>77.8%</td>
</tr>
<tr>
<td>Working full time</td>
<td>7</td>
<td>77.8%</td>
</tr>
<tr>
<td>Associate Degree in Nursing</td>
<td>1</td>
<td>11.1%</td>
</tr>
<tr>
<td>Diploma in Nursing</td>
<td>2</td>
<td>22.2%</td>
</tr>
<tr>
<td>Bachelor’s Degree in Nursing</td>
<td>4</td>
<td>44.4%</td>
</tr>
<tr>
<td>Master’s Degree in Nursing</td>
<td>2</td>
<td>22.2%</td>
</tr>
</tbody>
</table>

### 4.2.2. Pilot Study Results

The pilot study attained its intended objectives. The researcher met each subject in a private office at the study hospital at a mutually agreed upon time and was present while each subject completed the *WUSBIN* survey. Before administering the survey, the researcher explained the purpose of the pilot study and obtained informed consent. Participants were then given the option of completing the *WUSBIN* using either the paper or electronic version of the survey. After the subject was provided with the chosen version of the survey, the researcher began timer as the subject began the survey.
The first objective of the pilot test was to trial the survey’s verbiage for understandability. Subjects were encouraged to think out loud and ask questions while completing the survey. The researcher recorded notes regarding each subject’s questions and comments. When appropriate, the researcher answered or clarified questions or comments. After the pilot was completed, all comments and questions were compiled and tallied in order to identify repeated themes among subjects. Upon review of the themes, appropriate changes were made to the WUSBIN. In addition, the researcher chose to make minor edits to the instrument to further enhance the survey. There were a total of 13 edits made to the WUSBIN after the pilot study. Of these edits, nine were based on the direct comments and questions made by pilot subjects, while four were made at the discretion of the researcher. The most common survey items that were questioned or commented upon were numbers 14, 48, 49 and 51. In item 14, four subjects commented on the meaning of the phrase “drug information available”. Items 48 and 49 used an identical list of known workarounds and asked subjects which workarounds from the list have they ever used (item 48) and which workaround had they used the most (item 49); therefore, questions and comments regarding this list of workarounds referred to both items. Six different participants commented on seven different points regarding these items. In particular, most subjects (n=4) inquired how the eighth choice for both items was even possible. This choice stated, “scanned a patient ID code from another object not on the patient”. These subjects were unsure how this could occur. Appendix H summarizes a complete summary of pilot sample comments presented as 13 themes, the resultant changes made to the WUSBIN, and the edits made by the research.
The second pilot objective was to trial and compare the administration of the \textit{WUSBIN} electronically using \textit{Survey Monkey} and using paper. Four subjects (44.4\%) chose the electronic option, while the remaining five subjects (55.6\%) chose the paper option. Overall, subjects were indifferent about which version of the survey they completed and stated that they made an arbitrary decision regarding their choice of using paper or electronic formats. Despite subject ambivalence about format, most felt it was important to have both versions available during the data collection phase of the main study for subject convenience. There were no differences noted in the numbers or types of questions and comments that pilot subjects made, nor were there any isolated themes related to each survey version. All subjects completed 100\% of the survey items, regardless of the survey version used.

The third pilot objective was to determine survey completion time. Table 4.2 displays survey completion times by each subject and survey version. Each subject was timed while completing the WUSBIN. Timing began as the subject started to read the survey cover page and ended when the subject stated that they were done. Survey completion times ranged from 12 minutes (n=2; both paper) to 33 minutes (n=1; electronic version). The average completion time was 22.4 minutes. The recruitment and reminder e-mails were edited to state that the survey takes approximately 20 minutes.

Pilot study findings were applied to the \textit{WUSBIN} and the changes were submitted to both the Duquesne University and Guthrie Healthcare Institutional Review Boards (IRB) with an amendment application. Approval was granted by both boards (Appendix E) and the main study commenced within one week of these approvals.
Table 4.2

*WUSBIN pilot study completion times and versions (N=9)*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Time in minutes</th>
<th>Survey version</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>Paper</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>Electronic</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>Electronic</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>Paper</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>Electronic</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>Paper</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>Electronic</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>Paper</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>Paper</td>
</tr>
</tbody>
</table>

4.3 Administration of the *WUSBIN* and data cleaning

The target population for this study was registered nurses (RN) who utilize a BCMA system to administer medications to patients. An electronic version of the *WUSBIN* was made available to RNs for four weeks via *Survey Monkey*. Each of the e-mail communications to RNs contained a direct link to the electronic version of the study. At the two week data collection midpoint, paper versions of the WUSBIN were distributed to each of the qualifying patient care areas and at the hospital’s shared governance meetings in January 2012. At the closing date, 75 paper surveys had been distributed with 19 surveys (25%) returned. Additionally, 70 surveys (26%) were completed by participants and submitted via *Survey Monkey* during the data collection period, for a total response rate (paper and electronic) of 89 submitted surveys. No surveys were returned after the survey was closed on January 22, 2012. After this date,
the researcher manually entered the 19 completed paper surveys into Survey Monkey so that all study data was contained in one database. Among the 12 qualifying patient care areas, approximately 265 RNs were eligible to participate in the study, therefore yielding an initial return rate of 33.6% (89/265). In order to assure a high level of subject confidentiality, subjects were only asked to indicate whether they worked in a patient care area which was primarily inpatient or outpatient, but were not asked to specifically identify which area. Therefore, while there were surveys submitted from both inpatient and outpatient areas, it was not possible to identify participants by each patient care areas.

Before data analysis began, it was pre-determined that any survey with more than 5 items left blank (10%) in Part I blank would be considered “incomplete” and would not be used in the data analysis. Of the 89 submitted surveys, nine surveys (n=9, 10%) were considered incomplete. Four surveys were found to be totally empty. Five surveys were noted to be incomplete because items 18, 29, 34, 45 and 62 were missing responses. All nine of these incomplete surveys had been submitted electronically and were eliminated from the study database. These changes resulted in 80 usable surveys out of the original 89 surveys (90% of those submitted), leaving a final return rate of 30.2% (80/265). None of the paper surveys were found to have more than five items missing; therefore, all paper surveys were considered for data analysis.

4.4 Demographic Characteristics of the Sample

Part III of the WUSBIN contained 12 optional items which inquired about the participants’ demographics. Of the 80 usable surveys, one participant (n=1, 1.3%) did not respond to any demographics questions. Eight of the 12 survey items were not answered by two to four subjects each (including the one subject previously mentioned).
Because these study participants responded to at least 90% of the survey items in part I, they were included in the study. Therefore, the final sample demographics were based on no more than 79 subjects, as some subjects did answer all the demographic questions. Table 4.3 summarizes the demographic characteristics.

Of the nurses who answered the demographic questions, 71 (88.8%) were female. Participants represented all age categories, with most participants in the 21 to 30 (n=24; 30%) year age group. More than half of nurses possessed a bachelor of science in nursing (BSN) degree (n=44; 55%). Regarding employment and experience, 76.2% (n=61) of study subjects reported having been nurse longer than four years, and 63.9% (n=51) had been employed at the study hospital for longer than four years, which was when the BCMA system was implemented at the study hospital. The remaining subjects had not been in nursing long enough (n=17, 21.3%) and/or did not work at the study hospital before the current BCMA system was implemented (n=25; 31.3%). The majority of nurses, 83.3% (n=67) worked in an inpatient unit and 88.8% (n=71) worked fulltime in their departments. Nearly half of the study subjects worked either the night shift or rotated from day to evening shifts (n=18, 22.5% each). Just over half of the study subjects rotated between weekdays, weekends, and holidays (n=42, 52.5%). Nearly all subjects rated their computer skills compared to that of their peers as being either “above average” or “average” (n=37, 46.3% each). There were 75 (93.8%) subjects who reported they used a computer at home. Reflecting on their skills to retrieve patient information from the current computer system, about half (n=41, 51.2%) of the sample rated themselves as “good”.

83
Table 4.3

Demographic characteristics of main study sample (N=80)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>71</td>
<td>88.7</td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>10.0</td>
</tr>
<tr>
<td>Missing</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-30 years</td>
<td>24</td>
<td>30.0</td>
</tr>
<tr>
<td>31-40 years</td>
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<td>41-50 years</td>
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<td>51-60 years</td>
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<td>61-70 years</td>
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</tr>
<tr>
<td><strong>Highest nursing degree</strong></td>
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<td></td>
</tr>
<tr>
<td>Diploma</td>
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<td>15.0</td>
</tr>
<tr>
<td>Associate’s Degree</td>
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</tr>
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<td>Bachelor’s Degree</td>
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<td>11.2</td>
</tr>
<tr>
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<td>1.3</td>
</tr>
<tr>
<td><strong>Number of years in nursing</strong></td>
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<td></td>
</tr>
<tr>
<td>&lt; 4 years</td>
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</tr>
<tr>
<td>4-5 years</td>
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<td>26-30</td>
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<td>7.5</td>
</tr>
<tr>
<td>31-35</td>
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<td>11.2</td>
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<td>&gt;36 years</td>
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<td><strong>Number of years at study hospital</strong></td>
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</tr>
<tr>
<td>&lt; 4 years</td>
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<td>31.1</td>
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<tr>
<td>4-5 years</td>
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<td>15.0</td>
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<td>11-15</td>
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<td>16-20</td>
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<td>6.3</td>
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<td>&gt;36 years</td>
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<td>5.0</td>
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<tr>
<td>Unit Type</td>
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<tr>
<td>-------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Primarily inpatient</td>
<td>67</td>
<td>83.8</td>
</tr>
<tr>
<td>Primarily outpatient</td>
<td>11</td>
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<tr>
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<td>2.5</td>
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<thead>
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<th>Employment status</th>
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</thead>
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<td>Full time (includes weekend only option)</td>
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<td>88.8</td>
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<td>Part time</td>
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<td>3.7</td>
</tr>
<tr>
<td>Per diem</td>
<td>4</td>
<td>5.0</td>
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<td>2.5</td>
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<table>
<thead>
<tr>
<th>Shift Rotation</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All shift</td>
<td>12</td>
<td>5.0</td>
</tr>
<tr>
<td>All day shift</td>
<td>17</td>
<td>21.3</td>
</tr>
<tr>
<td>All evening shift</td>
<td>4</td>
<td>5.0</td>
</tr>
<tr>
<td>All night shift</td>
<td>18</td>
<td>22.5</td>
</tr>
<tr>
<td>Rotate days/eves</td>
<td>18</td>
<td>22.5</td>
</tr>
<tr>
<td>Rotate days/nights</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td>Rotate eves/nights</td>
<td>3</td>
<td>3.7</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weekly schedule</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly Monday-Friday</td>
<td>26</td>
<td>32.5</td>
</tr>
<tr>
<td>Mostly weekends/holidays</td>
<td>10</td>
<td>12.5</td>
</tr>
<tr>
<td>Rotate weekdays/weekends/holidays</td>
<td>42</td>
<td>52.5</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-rating of computer skills compared to peers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Above average</td>
<td>37</td>
<td>46.2</td>
</tr>
<tr>
<td>Average</td>
<td>37</td>
<td>46.2</td>
</tr>
<tr>
<td>Below average</td>
<td>4</td>
<td>5.0</td>
</tr>
<tr>
<td>Missing</td>
<td>2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Uses a computer at home</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>75</td>
<td>93.8</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Missing</td>
<td>3</td>
<td>3.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-rating of obtaining patient information from hospital computer system</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>33</td>
<td>41.3</td>
</tr>
<tr>
<td>Good</td>
<td>41</td>
<td>51.3</td>
</tr>
<tr>
<td>Fair</td>
<td>3</td>
<td>3.7</td>
</tr>
<tr>
<td>Poor</td>
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<td>2.5</td>
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<tr>
<td>Missing</td>
<td>1</td>
<td>1.2</td>
</tr>
</tbody>
</table>
4.5 BCMA Satisfaction

Nurse satisfaction with the current barcoding system at the study hospital was measured using the variable *BCMA Satisfaction*. There were two measures of this variable on the *WUSBIN*, the *Overall Satisfaction Score* and *BCMA Satisfaction Score*.

Overall satisfaction with the BCMA system was measured by WUSBIN item 1, which asked nurses to rate their overall satisfaction with the system using a 1-10 scale where 1 indicated “complete dissatisfaction” and 10 indicated “complete satisfaction” with the BCMA system. *Overall Satisfaction Scores* ranged from 1-10, with all 80 subjects (100%) responding to this survey item. In general, nurses were more satisfied than dissatisfied with the BCMA system ($\bar{x}=5.9$, $s=2.1$). Just over half the nurses rated the system with scores which indicated satisfaction ($n=46$, 57.6%), choosing scores between 6-10. More than a quarter of the nurses ($n=23$, 28.7%) rated their overall satisfaction with the system as an ‘8’. Nearly the same number of nurses ($n=22$, 27.5%) rated the system with scores indicating dissatisfaction, choosing scores between 1-4. See Figure 4.1 for the distribution of Overall Score distributions.
Figure 4.1 Overall Satisfaction Score Distribution (N=80)

The BCMA Satisfaction Score was measured using the WUSBIN items 2-19. Table 4.4 summarizes this variable. Possible scores for this variable were 18 to 108, with higher scores indicating higher levels of satisfaction. All responses were based on a 1 to 6 Likert scale where 1 indicated “completely satisfied” and 6 indicated “complete dissatisfied”. There was also a choice for ‘not applicable’ if the subject felt the survey item did not apply to their practice or were not sure how to respond. In order to ensure that each survey item was evaluated based on the same number of scores and that no score fell below the minimum score for each variable, responses of ‘not applicable’ were replaced with the average score for that survey item. Given that there were 18 items to be answered 80 times, there were 1,440 possible responses to items 1-18. Replacing ‘not applicable’ responses occurred 15 times (1%) when evaluating subject responses to BCMA Satisfaction survey items. BCMA Satisfaction Scores ranged from 18-101, with

Note. 1 = complete dissatisfaction; 10 = complete satisfaction
scores calculated for all 80 subjects. The average BCMA Satisfaction Score indicated moderately high satisfaction with the system ($\bar{x} = 76.2, s = 15.3$). This can be determined because the average score falls above the midpoint score (BCMA Satisfaction Score = 63), but below the upper quartile score (BCMA Satisfaction Score = 86). Both the average Overall Satisfaction Score and the BCMA Satisfaction Score fall in the third quartile on their respective scales. The Pearson correlation coefficient was calculated to determine the actual relationship between these two scores. A moderately strong positive correlation was found ($r(78) = .651, p < .01$), indicating a significant linear relationship between the Overall Satisfaction Score and the BCMA Satisfaction.

Table 4.4

<table>
<thead>
<tr>
<th>BCMA Satisfaction Measure</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Median</th>
<th>Mode</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Satisfaction</td>
<td>5.9</td>
<td>2.1</td>
<td>6</td>
<td>8</td>
<td>1-10</td>
</tr>
<tr>
<td>BCMA Satisfaction Score</td>
<td>76.2</td>
<td>15.3</td>
<td>78</td>
<td>82</td>
<td>18-101</td>
</tr>
</tbody>
</table>

4.6 Workaround Usage

4.6.1 Workaround Subscales: Perceived Ease of Use (PEOU) and Perceived Usefulness (PU)

The likelihood that nurses at the study hospital used workarounds in practice was measured by the variable Workaround Usage and was calculated by summing items 20-47. While there was only one major score which measured Workaround Usage, this score was broken down into two subscales, Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) which were also used to answer the study’s research
questions. Additionally, types and frequencies of workarounds were determined in survey items 48 and 49, respectively.

**Workaround Usage Score**

The *Workaround Usage* score was measured by *WUSBIN* items 20-47. Possible scores for this variable were 53-143, with higher scores indicating higher levels of workaround usage. All responses to *Workaround Usage* items were based on a 1 to 6 point Likert scale, where 1 indicated “completely satisfied” and 6 indicated “complete dissatisfied”. There was also a choice for ‘not applicable’ if the subject felt the survey item did not apply to their practice or were not sure how to respond. In order to ensure that each survey item was evaluated based on the same number of scores and that no score fell below the minimum score for the variable, responses of ‘not applicable’ were replaced with the average score for that survey item. Given there were 28 items to be answered 80 times, there were 2,240 possible responses to items 20-47. Replacing ‘not applicable’ responses occurred 53 times (2%) when evaluating subject responses to *Workaround Usage* survey items.

*Workaround usage* scores ranged from 41-138. Workaround usage among nurses at the study hospital, on average, was moderately low ($\bar{x} = 87.2, s = 15.4$). This determination can be made because the average score of 87.2 was below the midpoint of possible scores (*Workaround usage* score = 98), but above the second quarter of possible score (*Workaround usage* score = 76) for this measure.

**Perceived Ease of Use (PEOU) Score**

*PEOU* scores were measured from the sum of *WUSBIN* items 20-36 and 42-47. Possible scores ranged from 23-138, with higher scores indicating lower perceptions of
ease of use for the BCMA system. *PEOU* scores in this study ranged from 33-75, which indicated a fairly wide range of perceptions among the study nurses regarding how easy it was to use the BCMA system. The average *PEOU* score indicated that the ease of use of the system was moderately high ($\bar{x}=63.9$, $s=13.5$), as the average score for this variable was below the midpoint of possible scores (*PEOU* score=81), but above the second quarter of possible scores (*PEOU* score=51).

*Perceived Usefulness (PU) Score*

*PU* scores were measured from the sum of *WUSBIN* items 37-41. Possible scores ranged from 5-30, with higher scores indicating higher perceptions of BCMA usefulness. Study *PU* scores ranged from 5-30, also indicating a wide range of perceptions among the study nurses regarding the usefulness of the BCMA system. While perceptions were wide, the average perception of BCMA usefulness was moderately low ($\bar{x}=23.2$, $s=5.2$), indicating that nurses perceived that the system was not useful. This determination can be made because the average score of 23.2 was above the possible midpoint score (*PU* score = 17.5), but just below the upper quarter of possible scores (*PU* score = 23.8).

Nurses in this study found the BCMA system easy to use, but not useful. Table 4.5 summarizes the *Workaround Usage* variable.
4.6.2 Workaround Subscale: Workaround Types

There are many different types of BCMA workarounds which nurses may employ in their practice. Nurses in this study were asked to choose from a list of 13 common workarounds, those workarounds they have used in their practice (item 48), and the single workaround they used most often (item 49). When answering item 48, where subjects were asked which workarounds they have ever used, multiple answers were allowed. Workarounds that most subjects identified included: 1) scanned the same package multiple times when multiple packages of medication are required for the full dose (n=39, 49.4%); 2) administered a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts) (n=36, 45.6%); 3) and documented a medication administration before the medication is actually given to the patient/or observed the patient ingest it (n=33; 41.8%). When answering item 49, subjects were limited to just one choice and were asked to indicate which workaround they used most often. The list of workarounds was identical to the list in item 48. The same top three workarounds which most nurses previously admitted to using were also the top three workarounds which nurses admitted to using the most often. Workarounds most often utilized by nurses in this study included: 1) scanned the same package multiple times when multiple packages of medication are required for the full dose (n=17, 21.3%),
and 2) documented a medication administration before the medication is actually given to the patient/or observed the patient ingest it (n=17; 21.3%). The next workaround nurses stated they used the most often was: administered a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts) (n=11, 13.8%). Table 4.6 describes workarounds utilized by nurses in this study by comparing those utilized by the most nurses with workarounds which study nurses reported using most often. Table 4.6 reports workaround types and which workarounds were used most often.

Table 4.6

Types of workarounds and workarounds used most often (N=80)

<table>
<thead>
<tr>
<th>Workaround Description</th>
<th>Number (%) of nurses using this workaround</th>
<th>Number of nurses using this workaround most often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanned a medication from a patient drawer without a visual check of the eMar, medication name or dose</td>
<td>15(19)</td>
<td>2(2.5)</td>
</tr>
<tr>
<td>Administered a medication without reviewing parameters for administration</td>
<td>16(20.3)</td>
<td>2(2.5)</td>
</tr>
<tr>
<td>Reviewed a medication requiring a double check (i.e., PCA or Epidural medications) administered by another nurse without actually reviewing the medication</td>
<td>4(5.1)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Administered a new medication before verifying the new medication order</td>
<td>21(26.6)</td>
<td>6(7.5)</td>
</tr>
<tr>
<td>Administered a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts)</td>
<td>36(45.6)</td>
<td>11(13.8)</td>
</tr>
<tr>
<td>Administered a medication without scanning the medication barcode (does not include unsuccessful scanning attempts)</td>
<td>25(31.6)</td>
<td>4(5)</td>
</tr>
</tbody>
</table>
Documented a medication administration before the medication is actually given to the patient/or observed the patient ingest it 33(41.8) 17(21.3)

Scanned a patient ID code from another object not on the patient 23(29.1) 5(6.3)

Prepared, scanned and transported medications for more than one patient at a time 8(10.1) 3(3.8)

Scanned the medication barcode after the barcode label has been removed from the medication itself 15(19) 1(1.3)

Scanned the same package multiple times when multiple packages of medication are required for the full dose 39(49.4) 17(21.3)

Taken the scanner into the patient room and left the CAB outside the room where you cannot see it 30(38) 8(10)

Given a partial dose of a medication but documented that the entire dose was given 4(5) 0(0)

4.7 Subject comments related to BCMA Satisfaction and Workaround Usage

WUSBIN items 50 and 51 were open-ended optional questions, providing study subjects an opportunity to comment about the BCMA system. There was no limit to the number of characters or words the subjects could enter.

A conventional content analysis approach was taken to analyze the comments provided during this survey (Hseigh, H.F. & Shannon, S.E., 2005). The purpose for allowing comments within the WUSBIN was to enable subjects to further explain or describe, in their own words, their thoughts about the BCMA system. Their thoughts were important and helped provide the researcher with a clearer understanding of the relationship between the phenomena of BCMA satisfaction and workaround usage. This
opportunity was appropriate because theories of this relationship do not exist and the literature on each topic is minimal (Hseigh, H.F. & Shannon, S.E., 2005).

The conventional content analysis began with reading through each of the comments provided in the survey. Next, key words and phrases were highlighted and notes were made regarding the researcher’s first impressions. Codes were derived from the comments, which were then sorted into categories based on how they were related. Categories were then combined into larger groups as relationships were made evident (Hseigh, H.F. & Shannon, S.E., 2005).

4.7.1. Comments of safe and professional medication administration

Item 50 asked subjects to add any comments they had about the current BCMA system and the degree to which the system and its components supported safe and professional medication administration. There were 78 comments provided by 41 subjects (53%) to this item. Comments were coded and labeled into 13 groups with the number of comments noted: System: positive (2), System: negative (1), System: mixed (5), Scanners: negative (18), Scanners: positive (2), Computer at Bedside (CAB) (4), Equipment: general (6), Safety: (7), Time: saver (4), Time: waster (2), Wireless connection (4), Patient wristbands (4), Medications (19).

Next, comment groups with similar ideas were categorized together. The eight comments from the groups related to the system were categorized together and labeled “System”. Most comments were a combination of mixed positive and negative remarks (n=5; 62.5%) regarding the system. The comments began with an overall expression of liking the system, but these statements were qualified with concerns about how well the system worked. A typical comment was, “I like the barcoding system when it works”.

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Another comment stated, “The concept is good, but still has MANY faults”. The two groups describing the scanners were also pulled together into a category called “Scanners” (20). The majority of these comments expressed negative remarks about the scanners (n=18, 90%). Several nurses stated that scanners set them up to utilize workarounds because they (scanners) do not work well. Comments such as “I feel that scanning meds and patients would have a high score of completion if the equipment worked. Do you have any idea how frustrating it is when you’re trying to scan and it doesn’t work? That’s when you override the system to get your work done…”; “Very rarely do I complete a shift without overriding a medication due to the fact that the scanners NEVER work properly even when reset as we were taught ”and“ Ours NEVER work. In theory, this would be a great way to decrease med errors, however our scanners are ALWAYS broken,” illustrate this point. Nurses were frustrated with equipment that works inconsistently. Nurses commented that “most of the time scanners don’t work”; “Need scanners on the carts that work consistently” and “Our scanners do not work well—have to scan items multiple times”.

Overwhelmingly, nurses in this study blamed the scanners, which they perceived as being faulty for their use of workarounds. In light of this, there were seven comments categorized as “Safety”. All of these comments were very positive. Nurses were able to state safety benefits of BCMA. Benefits that were described included: 1) eliminating transcription errors; 2) warnings of wrong doses; 3) decreasing the chance of overdose; 4) improving efficiency; 5) prevents misreading of handwritten medication administration records; 6) providing current and up to date information. One nurse stated, “It is a very safe and secure system to administer medications to our patients safely. Love the
system”. The six comments related to time savers and time wasters were merged into one category called “Time”. Most comments (n=4, 67%) in this category describe the BCMA system as saving time, particularly because nurses no longer have to hand write/copy or hunt down paper medication administration records. The two negative comments stated that the BCMA system keeps nurses from their patients.

After this initial regrouping of obvious matches, when the comment categories were reviewed again it was noted that some of the categories were interrelated. As a result, the comment categories “Scanners” (20), “Equipment: general” (6) and CABs (4) were re-categorized into a group called “Equipment” (30). The category “Equipment: general” repeated many of the same themes found in the previously described categories of “System” and “Scanners”, but more generally referred to equipment, rather than the overall system or specifically the scanners. Repeated themes were noted in these comments: “Barcoding works well when the equipment works”, “The problem is the equipment. Too often I get barcodes that will not scan. So I sit there for a couple of minutes trying to get it to scan. It is a waste of time and frustrating,” and “They don’t support my ability to administer medications…they consume more of my time and concentration trying to get poor equipment to function”. Comments related to CABs (n=4) were all negative, alluding that this equipment did not work consistently. Nurses stated “…need batteries on the med cars that hold a longer charge and don’t black out during medication administration, which they seem to do often” and “It takes too long to get CABs worked on/fixed when there is a problem with them”.

In addition, the comment categories: “Wireless connection” (4), “Patient wristbands” (4) and “Medications” (19) were re-categorized into a group called “BCMA
requirements” (27). Comments related to “Wireless connection” described losing connectivity and being “booted off” the system. One nurse stated, “Often times connections to wireless technology is lost”. Comments related to “Patient wristbands” expressed concerns that the barcodes on bracelets are often printed too light, making them unreadable. One nurse stated that there are times when she does not awake patients to scan their wristbands, and another nurse noted that patients in the Intensive Care Area of the Behavioral Health Unit are not allowed to wear bracelets, so they are not scanned during medication administration.

Comments regarding medications generated the most single category remarks. Of the 19 comments in this category, seven (37%) described medications that do not scan well, three (16%) were pharmacy-related, two (11%) stated that some medications scanned incorrectly, two (11%) described situations when the nurse chooses not to scan medications, and five (26%) were of miscellaneous, single subject medication issues. Of the seven comments that described medications that do not scan well, four (57%) specifically mentioned IV bags or medications in IV partial fill bags as being problematic. One nurse simply stated, “Too many meds…don’t scan properly”. Nurses were also concerned that sometimes a medication may scan, but the system does not recognize it. One nurse stated: “moderately often I have meds scan as wrong med when med and dose correct”. Two nurses described situations when they don’t scan medications. A night nurse admitted that she/he frequently hangs IVs without scanning a sleeping patient. A second nurse (who did not specify a shift) stated: “The meds I give without scanning first are the patient’s pain meds when they are in great need immediately”.  

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Comments related to the pharmacy addressed communication with pharmacy staff and the incorrect labeling of medications. Miscellaneous comments described a nurse who always scans medications, difficulties passing medications to isolation patients, complicated processes related to administering medications with multiple routes, and removing the human component of medication administration. One nurse simply stated that BCMA “helps keep 5 rights/nurses accountable”.

A final review of the comments determined that the categories of “Time” and “Safety” were related because they were outcomes of the BCMA system. Therefore, a new category was created called “BCMA outcomes” (13) to include these two subcategories. The “Equipment” category was determined to be a subcategory of the BCMA requirements category. See Table 4.7 for a summary of this content analysis.

Table 4.7

WUSBIN (Item 50) content analysis summary
<table>
<thead>
<tr>
<th>Themes (number of comments)</th>
<th>Subthemes (number of comments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA System (8)</td>
<td>Positive (2)</td>
</tr>
<tr>
<td></td>
<td>Negative (2)</td>
</tr>
<tr>
<td></td>
<td>Mixed (4)</td>
</tr>
<tr>
<td>BCMA Outcomes (13)</td>
<td>Time (6)</td>
</tr>
<tr>
<td></td>
<td>• Saver (4)</td>
</tr>
<tr>
<td></td>
<td>• Waster (2)</td>
</tr>
<tr>
<td></td>
<td>Safety (7)</td>
</tr>
<tr>
<td>BCMA Requirements (57)</td>
<td>Wireless Connection (4)</td>
</tr>
<tr>
<td></td>
<td>Medications (19)</td>
</tr>
<tr>
<td></td>
<td>Equipment (30)</td>
</tr>
<tr>
<td></td>
<td>• CABs (4)</td>
</tr>
<tr>
<td></td>
<td>• General (6)</td>
</tr>
<tr>
<td></td>
<td>• Scanners (20)</td>
</tr>
<tr>
<td></td>
<td>--Positive (2)</td>
</tr>
<tr>
<td></td>
<td>--Negative (18)</td>
</tr>
</tbody>
</table>

### 4.8.2. Comments regarding BCMA System changes

Item 51 of the WUSBIN asked subjects to describe one thing of the current BCMA system that they would change if they could. This item solicited 76 comments by 55 subjects (72%). Following the same procedure as described above, a conventional content analysis was conducted. Initially, there were 10 categories identified with the number of comments noted as follows: “Computers/scanners in room” (7); “Medication barcodes” (9); “Patient ID bands” (2); “Staff education” (2),” CABs” (12), “Faulty equipment” (4); “Reliability” (5); “Scanners and barcodes” (5); “Better scanners” (24);
“Cordless scanners (6)”. Next, common categories were consolidated to keep related topics together. In this step, a new category called “Scanner issues” with 35 comments was created to include the initial categories of “Scanners and barcodes”, “Cordless scanners” and “Better scanners”. Issues addressed in the category of “Scanners and barcodes” included nurses wanting these to work. Nurses stated: “make sure that all scanners and barcodes are always working” and “the current scanners/barcodes on meds only work 50% of the time at best. Need better barcodes/scanners”. Comments in the second subcategory, “cordless scanners” both suggested that current cordless scanners need improvement and that all scanners should be cordless (currently, the BCMA system utilizes both tethered and cordless scanners). The greatest number of comments in this category (n=24, 69%) were related to the need for “Better scanners”. Overwhelmingly, every comment in this category stated, directly or indirectly, that the nurses want scanners that work properly. One nurse asked for “new scanners so you’re not scanning multiple times to get it to work”. A second nurse supported this by stating, “It is rare when the scanners work at all, and never do they work flawlessly. I would like to have scanners that work properly”. Lastly, a few nurses described that scanners used in the retail world were more reliable than those in healthcare. Specifically, one nurse stated:

Get scanners that work. Spending a lot of time scanning medication and patient ID bands multiple times trying to get them to read. Grocery stores scan thousands of items a day and never see them with a scanning problem. We are talking about PEOPLE’S lives with certain medications and it is ridiculous the time spent on trying to get scanners to read. I love the bar coding system, just hate the inadequate equipment.
During the last review of categories, two overriding themes were identified and categories were condensed. The first new category created was “Fix the BCMA tools” and consisted of the subcategories of “Scanner issues” (as described above), “Faulty equipment”, “CABs”, “medication barcodes,” and “patient wristbands”. The subcategory of “Faulty equipment” consisted of requests for fixing equipment, in general. Issues addressed in the “CAB” subcategory included CAB maintenance, CAB batteries and drawers locking, CAB availability, isolation CABs, the general need for better CABs and CAB portability. CABs were noted to be heavy and noisy. One nurse stated: “I wish there were a hand held scanner/laptop to administer pain medications. I feel very disruptive driving a large computer on wheels into a patient room...just to deliver 1 pill”. Another nurse was frustrated when trying to find a CAB and stated, “It is very time consuming to find a CAB that is not being used just so you can use that scanner especially trying to give medications quickly like pain meds or sedation meds. It was concerning that one nurse commented that it was not easy to get a CAB for an isolation room, stating: “I find that when there isn’t an isolation CAB, those are the times I don’t take the CAB in the room and scan the bracelet. I do however; make the patient show me their bracelet so I can verify with my own eyes that the information is correct”. The subcategory of “Medication barcodes” primarily identified the need for better barcode labels on medications (n=7, 78%). The remaining two comments identified that once a medication is opened, it is impossible to keep the barcode intact and the need for a way to obtain medication-specific information directly from the medication name itself (currently, the nurse must leave the electronic medication administration record to obtain this information). There were only two comments in the subcategory of “Patient bands”.

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One implied the need for bands which were printed darker and the other suggested that the Behavioral Health Unit needed bands that were safe for all patients.

The second new category was named “Recommendations for change” (14) and consists of the subcategories of “Staff education”, “Reliability” and “Computers/scanners in room”. There were only two comments in the subcategory of “Staff education”. One comment requested education on a specific medication issue and the other suggested that more education and monitoring were needed to reduce problems. “Reliability” comments were of a general nature and stated that the system needed to be more reliable. One nurse stated that when equipment is not reliable, she/he would like it to be understood that she needs replacement equipment immediately. Lastly, nurses were interested in having BCMA equipment at the bedside as permanent equipment in the room. Comments related to this topic resulted in the creation of the subcategory “Computers/scanners in room”. One nurse stated: “I would put stations in patient rooms with computers and locked drawers so: A) I would always have one available when in the room with the patient; B) I wouldn’t get kicked off (loose connection); and C) CABs are a pain in the joints to push around all day, obstruct the hallways and obstruct vision…”. Another nurse felt “smaller scanning systems (instead of a cart—something hand held or stationary in every room)” was a better option than the current equipment. See Table 4.8 for a summary of this content analysis.

Table 4.8

<table>
<thead>
<tr>
<th>WUSBIN (Item 51) content analysis summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themes (number of comments)</td>
</tr>
</tbody>
</table>

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4.8 The relationship between BCMA Satisfaction and Workaround Usage

This study aimed to determine the relationship between the two main study variable of BCMA Satisfaction and Workaround Usage.

Question 1. What is the relationship between registered nurse (RN) satisfaction with barcode medication administration (BCMA) and their workaround usage?

H₀: There is no relationship between registered nurse (RN) satisfaction with barcode medication administration (BCMA) and their use of workarounds.

Hₐ: There is a negative correlation between registered nurse (RN) satisfaction with barcode medication administration (BCMA) and their workaround usage.

Both variables in this research question are interval scale measures, requiring the use
of the Pearson’s Correlation Coefficient ($r^2$) to determine the relationship. A moderate negative correlation was found ($r^2(78) = -.681, p < .05$), indicating that as BCMA satisfaction goes up, workaround usage declines. The null hypothesis is rejected. Table 4.9 describes the relationship.

Table 4.9

The significant relationships between BCMA Satisfaction and Workaround Usage (N=80)

<table>
<thead>
<tr>
<th>BCMA Satisfaction</th>
<th>Pearson Correlation</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-.681*</td>
<td>.000</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: *Correlation is significant at the .01 level (2-tailed)

4.9 The relationship between BCMA satisfaction and PEOU, PU and workarounds used

Further analysis of the relationship between BCMA Satisfaction and Workaround Usage leads the researcher to inquire about the relationship between the variables of PEOU and PU with BCMA Satisfaction. In addition, the type and number of workarounds used may also be related to BCMA Satisfaction.

Question 2. Does BCMA satisfaction affect perceptions of ease of use (PEOU) of BCMA, perceptions of usefulness (PU) of BCMA and workarounds used, as measured by the WUSBIN?

H₀: There is no relationship between BCMA satisfaction and perceptions of ease of use (PEOU) of BCMA or perceptions of usefulness (PU) of BCMA, as measured by the WUSBIN.
Hₐ: There is a negative correlation between BCMA satisfaction and perceptions of ease of use (PEOU) of BCMA. perceptions of usefulness (PU) of BCMA, as measured by the WUSBIN.

4.9.1 BCMA Satisfaction and PEOU/PU relationship

The variables in this research question are interval scale measures, requiring the use of the Pearson’s Correlation Coefficient (r²) to determine the relationship. A strong negative correlation was found (r²(78) = -0.725, p < .05). As BCMA Satisfaction increases, nurse perception of ease of use also increases since high BCMA Satisfaction Scores indicate high satisfaction and low PEOU Scores indicate high perceptions of ease of use. This part of the null hypothesis is rejected. Table 4.10 describes this test.

Table 4.10

<table>
<thead>
<tr>
<th>BCMA Satisfaction</th>
<th>Perceived Ease of Use (PEOU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>-.725*</td>
</tr>
<tr>
<td>Sig (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: *Correlation is significant at the .01 level (2-tailed)

To examine the relationship between BCMA Satisfaction and PU, a Pearson correlation was calculated. A weak negative correlation that was not significant was found (r²(78) = -.127, p > .05). BCMA Satisfaction is not related to PU. This means that nurse satisfaction with the BCMA system does not influence how useful they perceive the system to be. This part of the null hypothesis fails to be rejected. Table 4.11 describes this test.

Table 4.11
### BCMA Satisfaction and Perceived Usefulness (PU)

<table>
<thead>
<tr>
<th>BCMA Satisfaction</th>
<th>Pearson Correlation</th>
<th>Sig (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-.127</td>
<td>.262</td>
</tr>
<tr>
<td>N</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

Note: *Correlation is significant at the .01 level (2-tailed)

### 4.9.2 BCMA Satisfaction and types of workarounds used

The first hypothesis to understand this relationship is:

\[ H_0: \text{There is no relationship between BCMA satisfaction and the type of workarounds used, as measured by the WUSBIN.} \]

\[ H_a: \text{There is a relationship between BCMA satisfaction and the type of workarounds used, as measured by the WUSBIN.} \]

This relationship will be determined using WUSBIN survey item 48 that measures which workarounds nurses use, regardless of frequency. For the purpose of conducting a proper analysis, the BCMA Satisfaction was tested against use or non-use of each of the 13 workaround types in the WUSBIN, survey item 48. Treating BCMA satisfaction as the dependent variable, and each of the type of workarounds as an independent variable with two levels (used and not used), the independent t-test was used to see whether each type of workaround was related to the BCMA satisfaction. This approach was used for all 13 hypotheses generated from this research question. Hypotheses are written here and grouped, first by discussing significant relationships between BCMA Satisfaction and each workaround described in the WUSBIN, and then those which were not found to be significant. Of the 13 hypotheses, six (46%) were found to have significant relationships among BCMA Satisfaction and the following: 1) scanning a medication from a patient
drawer without a visual check; 2) administering a medication without reviewing parameters for administration; 3) administering a new medication before verifying the new medication order; 4) preparing, scanning and transporting medications for more than one patient at a time; 5) scanning the medication barcode after the barcode label has been removed from the medication itself and 6) giving a partial dose of a medication but documenting that the entire dose was given. Tables 4.12 and 4.13 summarize the results.

The following null hypotheses were rejected:

H₀: There is no relationship between level of *BCMA Satisfaction* and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the *WUSBIN*.

Hₐ: There is a relationship between level of *BCMA Satisfaction* and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the *WUSBIN*.

The independent *t*-test comparing the mean scores of *BCMA Satisfaction* and scanning a medication from a patient drawer without the appropriate visual checks found a significant difference between the means of the two groups (*t*(78) = 2.423, *p* < .05). The *BCMA Satisfaction* mean (\( \bar{x} = 78.1, s = 14.5 \)) was significantly higher than the mean of those who used this workaround (\( \bar{x} = 67.8, s = 16.7 \)).

H₀: There is no relationship between level of *BCMA satisfaction* and administering a medication without reviewing parameters for administration, as measured by the *WUSBIN*. 
H₀: There is a relationship between level of BCMA satisfaction and administering a medication without reviewing parameters for administration, as measured by the WUSBIN.

The independent t-test comparing the mean scores of BCMA Satisfaction and administering a medication without proper review found a significant difference between the means of the two groups ($t(78) = 2.067, p < .05$). The BCMA Satisfaction mean ($\bar{x} = 77.9, s = 14.9$) was significantly higher than the mean of those who used this workaround ($\bar{x} = 69.3, s = 15.7$).

H₀: There is no relationship between level of BCMA satisfaction and administering a new medication before verifying the new medication order, as measured by the WUSBIN.

H₁: There is a relationship between level of BCMA satisfaction and administering a new medication before verifying the new medication order, as measured by the WUSBIN.

The independent t-test comparing the mean scores of BCMA Satisfaction and administering a new medication without verification found a significant difference between the means of the two groups ($t(78) = 2.743, p < .05$). The BCMA Satisfaction mean ($\bar{x} = 78.9, s = 14.8$) was significantly higher than the mean of those who used this workaround ($\bar{x} = 68.6, s = 14.5$).

H₀: There is no relationship between level of BCMA satisfaction and prepared, scanned and transported medications for more than one patient, as measured by the WUSBIN.
Hₐ: There is a relationship between level of *BCMA satisfaction* and prepared, scanned and transported medications for more than one patient, as measured by the *WUSBIN*.

The independent *t*-test comparing the mean scores of *BCMA Satisfaction* and preparing medications for multiple patients found a significant difference between the means of the two groups (*t*(78) = 2.968, *p* < .05). The *BCMA Satisfaction* mean (\( \bar{x} = 77.8, s = 15.0 \)) was significantly higher than the mean of those who used this workaround (\( \bar{x} = 61.6, s = 10.5 \)).

H₀: There is no relationship between level of *BCMA satisfaction* and scanning the medication barcode after the barcode label has been removed from the medication itself, as measured by the WUSBIN.

Hₐ: There is a relationship between level of *BCMA satisfaction* and scanning the medication barcode after the barcode label has been removed from the medication itself, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *BCMA Satisfaction* and scanning after removal of the barcode label found a significant difference between the means of the two groups (*t*(78) = 2.341, *p* < .05). The *BCMA Satisfaction* mean (\( \bar{x} = 78.0, s = 14.3 \)) was significantly higher than the mean of those who used this workaround (\( \bar{x} = 68.0, s = 17.5 \)).

H₀: There is no relationship between level of *BCMA satisfaction* and given a partial dose of a medication but documented that the entire dose was given, as measured by the WUSBIN.
Hₐ: There is a relationship between level of *BCMA satisfaction* and given a partial dose of a medication but documented that the entire dose was given, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *BCMA Satisfaction* and giving a partial dose, despite documenting the entire dose, found a significant difference between the means of the two groups (*t*(78) = 2.741, *p* < .05). The *BCMA Satisfaction* mean (\(\bar{x} = 77.2, s = 14.1\)) was significantly higher than the mean of those who used this workaround (\(\bar{x} = 56.5, s = 26.2\)).

Table 4.12

*BCMA Satisfaction* and significant workarounds used

<table>
<thead>
<tr>
<th>Workaround</th>
<th>t-score</th>
<th>df</th>
<th>Significance (2 tailed)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanned medication without visual check</td>
<td>2.423</td>
<td>78</td>
<td>.018</td>
<td>78.1</td>
<td>14.5</td>
</tr>
<tr>
<td>Administered a medication without reviewing</td>
<td>2.067</td>
<td>78</td>
<td>.042</td>
<td>78.0</td>
<td>14.9</td>
</tr>
<tr>
<td>parameters</td>
<td></td>
<td></td>
<td></td>
<td>69.3</td>
<td>15.7</td>
</tr>
<tr>
<td>Administered a new medication without verifying</td>
<td>2.743</td>
<td>78</td>
<td>.008</td>
<td>78.9</td>
<td>14.8</td>
</tr>
<tr>
<td>the order</td>
<td></td>
<td></td>
<td></td>
<td>68.6</td>
<td>14.5</td>
</tr>
<tr>
<td>Prepared, scanned and transported</td>
<td>2.968</td>
<td>78</td>
<td>.004</td>
<td>77.8</td>
<td>15.0</td>
</tr>
</tbody>
</table>
The following null hypotheses failed to be rejected:

$H_0$: There is no relationship between level of BCMA satisfaction and reviewing a medication requiring a double check (i.e., PCA or Epidural) administered by another nurse without actually reviewing the medication, as measured by the WUSBIN.

$H_a$: There is a relationship between level of BCMA satisfaction and reviewing a medication requiring a double check (i.e., PCA or Epidural) administered by another nurse without actually reviewing the medication, as measured by the WUSBIN.

The independent $t$-test comparing the mean scores of BCMA Satisfaction and reviewing a medication requiring a double check without actually reviewing the medication did not find a significant difference between the means of the two groups ($t(78) = 1.510, p > .05$). The BCMA Satisfaction mean ($\bar{x} = 76.8, s = 14.3$) was not significantly different than the mean of those who used this workaround ($\bar{x} = 85.0, s = 30.2$).
Ho: There is no relationship between level of BCMA satisfaction and administering a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

Ha: There is a relationship between level of BCMA satisfaction and administering a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

The independent t-test comparing the mean scores of BCMA Satisfaction and administering a medication without scanning the patient ID band did not find a significant difference between the means of the two groups ($t(78) = 1.585, p > .05$). The BCMA Satisfaction mean ($\bar{x} = 78.6, s = 15.7$) was not significantly different than the mean of those who used this workaround ($\bar{x} = 73.2, s = 14.6$).

Ho: There is no relationship between level of BCMA satisfaction and administering a medication to a patient without scanning the medication barcode (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

Ha: There is a relationship between level of BCMA satisfaction and administering a medication to a patient without scanning the medication barcode (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

The independent t-test comparing the mean scores of BCMA Satisfaction and administering a medication without scanning the medication barcode did not find a significant difference between the means of the two groups ($t(78) = .611, p > .05$). The BCMA Satisfaction mean ($\bar{x} = 76.9, s = 15.4$) was not significantly different than the mean of those who used this workaround ($\bar{m} = 74.6, s = 15.5$).
\( H_0: \) There is no relationship between level of *BCMA satisfaction* and documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it, as measured by the WUSBIN.

\( H_a: \) There is a relationship between level of *BCMA satisfaction* and documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *BCMA Satisfaction* and Documenting a medication administration before giving it to the patient/or actual ingestion did not find a significant difference between the means of the two groups \( (t(78) = 1.485, p > .05) \). The *BCMA Satisfaction* mean \( (\bar{x} = 78.3, s = 12.1) \) was not significantly different than the mean of those who used this workaround \( (\bar{x} = 73.2, s = 18.8) \).

\( H_0: \) There is no relationship between level of *BCMA satisfaction* and scanned a patient ID code from another object not on the patient, as measured by the WUSBIN.

\( H_a: \) There is a relationship between level of *BCMA satisfaction* and scanned a patient ID code from another object not on the patient, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *BCMA Satisfaction* and scanning a patient ID code from another object did not find a significant difference between the means of the two groups \( (t(78) = -.204, p > .05) \). The *BCMA Satisfaction* mean \( (\bar{x} = 76.0, s = 14.8) \) was not significantly different than the mean of those who used this workaround \( (\bar{x} = 76.8, s = 17.0) \).
H₀: There is no relationship between level of BCMA satisfaction and documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it, as measured by the WUSBIN.

Hₐ: There is a relationship between level of BCMA satisfaction and documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it, as measured by the WUSBIN.

The independent t-test comparing the mean scores of BCMA Satisfaction and scanning the same package multiple times when multiple packages of medication required for the full dose did not find a significant difference between the means of the two groups (t(78) = .841, p > .05). The BCMA Satisfaction mean (x̄ = 77.6, s = 12.5) was not significantly different than the mean of those who used this workaround (x̄ = 74.8, s = 17.9).

H₀: There is no relationship between level of BCMA satisfaction and taking the scanner into the patient room and leaving the CAB outside the room where you cannot see it, as measured by the WUSBIN.

Hₐ: There is a relationship between level of BCMA satisfaction and taking the scanner into the patient room and leaving the CAB outside the room where you cannot see it, as measured by the WUSBIN.

The independent t-test comparing the mean scores of BCMA Satisfaction and taking the scanner in the room and leaving the CAB where you cannot see it did not find a significant difference between the means of the two groups (t(78) = .887, p > .05). The BCMA Satisfaction mean (x̄ = 77.4, s = 14.1) was not significantly different than the mean of those who used this workaround (x̄ = 74.2, s = 17.4).
Table 4.13  *BCMA Satisfaction* and workarounds used not found to be significant

<table>
<thead>
<tr>
<th>Workaround</th>
<th>t-score</th>
<th>df</th>
<th>Significance (2 tailed)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviewed a medication requiring a double check</td>
<td>1.510</td>
<td>78</td>
<td>.135</td>
<td>76.8</td>
<td>14.3</td>
</tr>
<tr>
<td>Administered a medication without scanning ID band</td>
<td>1.585</td>
<td>78</td>
<td>.117</td>
<td>78.6</td>
<td>15.7</td>
</tr>
<tr>
<td>Administered a medication without scanning the medication barcode</td>
<td>.611</td>
<td>78</td>
<td>.543</td>
<td>76.9</td>
<td>15.4</td>
</tr>
<tr>
<td>Documented a medication before actually given</td>
<td>1.485</td>
<td>78</td>
<td>.142</td>
<td>78.3</td>
<td>12.1</td>
</tr>
<tr>
<td>Scanned a patient ID from other object</td>
<td>-.204</td>
<td>78</td>
<td>.839</td>
<td>76.0</td>
<td>14.8</td>
</tr>
<tr>
<td>Scanned the same package multiple times</td>
<td>.841</td>
<td>78</td>
<td>.403</td>
<td>77.6</td>
<td>12.5</td>
</tr>
<tr>
<td>Taken the scanner</td>
<td>.887</td>
<td>78</td>
<td>.378</td>
<td>77.4</td>
<td>14.1</td>
</tr>
</tbody>
</table>

115
4.9.3. BCMA Satisfaction and number of workarounds used

The second hypothesis to understand this relationship”

\( H_0: \) There is no relationship between BCMA satisfaction and the number of workarounds used, as measured by the WUSBIN.

\( H_a: \) There is a relationship between BCMA satisfaction and the number of workarounds used, as measured by the WUSBIN.

This hypothesis can be analyzed by considering the total number of workarounds used, which was determined by counting the total number workarounds for each nurse, as identified in the WUSBIN, survey item 48. A Pearson correlation coefficient was calculated for the relationship between BCMA Satisfaction and the total number of workarounds used. A weak, positive correlation was found (\( r(78) = -.393, p < .01 \)), indicating that as BCMA Satisfaction increases, the number of workarounds utilized decreases. Table 4.14 illustrates this relationship.

Table 4.14

<table>
<thead>
<tr>
<th>BCMA Satisfaction</th>
<th>Pearson Correlation</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-.393*</td>
<td>.000</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: *Correlation is significant at the .01 level (2-tailed)

4.10 The relationship between Workaround Usage and PEOU, PU and workarounds used

The next research question in this study explores the relationship between how
Nurses rated their actual usage of workarounds (*Workaround Usage*) with their perceptions of how easy it is to use the BCMA system (PEOU), how useful they perceive the system to be (PU), and which workarounds they use, as well as the total number of workarounds they state they use.

**Question 3:** Does workaround usage affect *PEOU* of BCMA, *PU* of BCMA and workaround used, as measured by the *WUSBIN*?

The first hypothesis testing this relationship is:

H₀: There is no relationship between workaround usage and perceptions of ease of use (*PEOU*) of BCMA or perceptions of usefulness (*PU*) of BCMA, as measured by the *WUSBIN*.

Hₐ: There is a positive correlation between *Workaround Usage* and perceptions of ease of use (*PEOU*) of BCMA perceptions of usefulness (*PU*) of BCMA, as measured by the *WUSBIN*.

4.10.1 *Workaround Usage* and *PEOU/PU* relationship

The variables in this research question are interval scale measures, requiring the use of the Pearson’s Correlation Coefficient ($r^2$) to determine the relationship. A strong positive correlation was found ($r^2(78) = .943, p < .05$). As workaround usage increases, nurse perception of ease of use decreases since high *Workaround Usage Scores* indicate high workaround use levels and high *PEOU Scores* indicate low perceptions of ease of use. This part of the null hypothesis is rejected. Table 4.15 describes this test.

Table 4.15

*Workaround Usage and PEOU*
To examine the relationship between Workaround Usage and PU, a Pearson correlation was calculated. A moderate positive correlation was found ($r^2(78)=.501$, $p < .05$). As workaround usage increases, nurse perception of how useful the system is decreases since high Workaround Usage Scores indicate high workaround use levels and high PU scores indicate low perceptions of usefulness. This part of the null hypothesis is also. Table 4.16 describes this test.

### Table 4.16

<table>
<thead>
<tr>
<th>Workaround Usage</th>
<th>Pearson Correlation</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Ease of use (PEOU)</td>
<td>.943*</td>
<td>.000</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: *Correlation is significant at the .01 level (2-tailed)

4.10.2 Workaround Usage and types of workarounds used

The first hypothesis to understand this relationship is:

$H_0$: There is no relationship between Workaround Usage and the type of workarounds used, as measured by the WUSBIN.
Hₐ: There is a relationship between Workaround Usage and the type of workarounds used, as measured by the WUSBIN.

This relationship will be determined using WUSBIN survey items 48. This item measures which workarounds nurses use, regardless of frequency. For the purpose of conducting a proper analysis, the Workaround Usage will be tested against use or non-use of each of the 13 workaround types in the WUSBIN, survey item 48.

Treating Workaround Usage as the dependent variable, and each of the types of workaround as an independent variable with two levels (used and not used), the independent $t$-test is used to see whether each type of workaround is related to Workaround Usage. This approach is for all 13 hypotheses generated from this research question. Hypotheses will be written here and grouped, first by discussing significant relationships between Workaround Usage and each workaround described in the WUSBIN, and then those which were not found to be significant. Of the 13 hypotheses, five (38%) were found to have significant relationships. The significant relationships were found among the variable of Workaround Usage and the following: 1) scanning a medication from a patient drawer without a visual check of the e-MAR, medication name or dose; 2) documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it; 3) prepared, scanned and transported medications for more than one patient at a time; 4) taken the scanner into the patient room and left the CAB outside the room where you cannot see it and 5) given a partial dose of a medication but documented that the entire dose was given. Tables 4.17 and 4.18 summarize the results of this test.
Significant relationships were not found between the variable of BCMA Satisfaction and remaining 7 (54%) workarounds. The workarounds which were not found to be significantly related to BCMA Satisfaction were: 1) reviewed a medication requiring a double check (i.e., PCA or Epidural medications) administered by another nurse without actually reviewing the medication; 2) administered a medication to a patient without scanning the ID band (does not include unsuccessful scanning attempts); 3) administered a medication without scanning the medication barcode (does not include unsuccessful scanning attempts); 4) documented a medication administration before the medication is actually given to the patient/or observed the patient ingest it; 5) scanned a patient ID code from another object not on the patient; 6) scanned the same package multiple times when multiple packages of medication are required for the full dose and 7) taken the scanner into the patient room and left the CAB outside the room where you cannot see it.

The following null hypotheses were rejected and their corresponding alternate hypotheses were accepted:

H₀: There is no relationship between level of Workaround Usage and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the WUSBIN.

Hₐ: There is a relationship between level of Workaround Usage and scanning of a medication from a patient drawer without a visual check of the e-Mar, medication name or dose as measured by the WUSBIN.

The independent t-test comparing the mean scores of Workaround Usage and scanning a medication from a patient drawer without the appropriate visual checks found a significant difference between the means of the two groups (t(78) = -1.930, p < .05).
Workaround Usage mean ($\bar{x} = 85.5, s = 14.5$) was significantly lower than the mean of those who used this workaround ($\bar{x} = 98.1, s = 15.6$).

$H_0$: There is no relationship between level of Workaround Usage and documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it, as measured by the WUSBIN.

$H_a$: There is a relationship between level of Workaround Usage and documenting a medication administration before the medication is actually given to the patient/or observed the patient ingest it, as measured by the WUSBIN.

The independent $t$-test comparing the mean scores of Workaround Usage and documenting a medication administration before the medication is actually given found a significant difference between the means of the two groups ($t(78) = -2.381, p < .05$). The Workaround Usage mean ($\bar{x} = 83.8, s = 12.8$) was significantly lower than the mean of those who used this workaround ($\bar{x} = 91.9, s = 17.5$).

$H_0$: There is no relationship between level of Workaround Usage and prepared scanned and transported medications for more than one patient at a time, as measured by the WUSBIN.

$H_a$: There is a relationship between level of Workaround Usage and prepared, scanned and transported medications for more than one patient at a time, as measured by the WUSBIN.

The independent $t$-test comparing the mean scores of Workaround Usage and preparing, scanning and transporting medications for multiple patients found a significant difference between the means of the two groups ($t(78) = -3.886, p < .05$). The Workaround
Usage mean ($\bar{x} = 85.1, s = 14.1$) was significantly lower than the mean of those who used this workaround ($\bar{x} = 105.6, s = 14.8$).

$H_0$: There is no relationship between level of *Workaround Usage* and taken the scanner into the patient room and left the CAB outside the room where you cannot see it, as measured by the WUSBIN.

$H_a$: There is a relationship between level of *Workaround Usage* and taken the scanner into the patient room and left the CAB outside the room where you cannot see it, as measured by the WUSBIN.

The independent $t$-test comparing the mean scores of *Workaround Usage* and taking the scanner into the room and leaving the CAB outside the room, out of sight, found a significant difference between the means of the two groups ($t(78) = -2.120, p < .05$). The *Workaround Usage* mean ($\bar{x} = 84.4, s = 13.0$) was significantly lower than the mean of those who used this workaround ($\bar{x} = 91.8, s = 18.0$).

$H_0$: There is no relationship between level of *Workaround Usage* and giving the patient a partial dose of medication but documenting the entire dose was given, as measured by the WUSBIN.

$H_a$: There is a relationship between level of *Workaround Usage* and giving the patient a partial dose of medication but documenting the entire dose was given, as measured by the WUSBIN.

The independent $t$-test comparing the mean scores of *Workaround Usage* and giving a partial medication dose but documenting the entire dose was given found a significant difference between the means of the two groups ($t(78) = -2.120, p < .05$). The
Workaround Usage mean ($\bar{x} = 85.9, s = 14.0$) was significantly lower than the mean of those who used this workaround ($\bar{x} = 110.8, s = 23.1$).

Table 4.17

Workaround Usage and Significant Workarounds Used

<table>
<thead>
<tr>
<th>Workaround Usage</th>
<th>t-score</th>
<th>df</th>
<th>Significance (2 tailed)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanned medication without visual check</td>
<td>-3.223</td>
<td>78</td>
<td>.002</td>
<td>85.5</td>
<td>14.5</td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>-2.381</td>
<td>78</td>
<td>.020</td>
<td>83.8</td>
<td>12.8</td>
</tr>
<tr>
<td>Documented a medication administration before the medication is actually given to the patient or/observed the patient ingest it</td>
<td>-3.886</td>
<td>78</td>
<td>.000</td>
<td>85.1</td>
<td>14.1</td>
</tr>
<tr>
<td>Prepared, scanned and transported medication for more than one patient</td>
<td>-2.120</td>
<td>78</td>
<td>.037</td>
<td>84.4</td>
<td>13.0</td>
</tr>
<tr>
<td>Taken the scanner into the patient room and left the CAB outside the room where you cannot see it</td>
<td>-3.344</td>
<td>78</td>
<td>.001</td>
<td>85.9</td>
<td>14.0</td>
</tr>
<tr>
<td>Given a partial dose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Significant relationships were not found between the variable of Workaround Usage and remaining 8 (62%) workarounds. The workarounds which were not found to be significantly related to Workaround Usage were: 1) administered a medication without reviewing parameters for administration; 2) reviewed a medication requiring a double check (i.e., PCA or Epidural medications) administered by another nurse without actually reviewing the medication; 3) administered a new medication before verifying the new medication order; 4) administered a medication to a patient without scanning the ID band (does not include unsuccessful scanning attempts); 5) administered a medication without scanning the medication barcode (does not include unsuccessful scanning attempts); 6) scanned a patient ID code from another object not on the patient; 7) scanned the medication barcode after the barcode label has been removed from the medication itself; 8) scanned the same package multiple times when multiple packages of medication are required for the full dose. The following null hypotheses failed to be rejected:

H₀: There is no relationship between level of Workaround Usage and administering a medication without reviewing the parameters for administration, as measured by the WUSBIN.

H₁: There is a relationship between level of Workaround Usage and administering a medication without reviewing the parameters for administration, as measured by the WUSBIN.
The independent *t*-test comparing the mean scores of *Workaround Usage* and administering a medication without reviewing the parameters for administration did not find a significant difference between the means of the two groups (*t*(78) = -3.223, *p* > .05). The *Workaround Usage* mean (\(\bar{x} = 85.5, s = 14.5\)) was not significantly different than the mean of those who used this workaround (\(\bar{x} = 93.4, s = 17.6\)).

**H\(_0\):** There is no relationship between level of *Workaround Usage* and reviewing a medication requiring a double check (i.e., PCA or Epidural) administered by another nurse without actually reviewing the medication, as measured by the *WUSBIN*.

**H\(_a\):** There is a relationship between level of *Workaround Usage* and reviewing a medication requiring a double check (i.e., PCA or Epidural) administered by another nurse without actually reviewing the medication, as measured by the *WUSBIN*.

The independent *t*-test comparing the mean scores of *Workaround Usage* and reviewing a medication requiring a double check without actually reviewing the medication did not find a significant difference between the means of the two groups (*t*(78) = -.211, *p* > .05). The *BCMA Satisfaction* mean (\(\bar{x} = 87.1, s = 14.1\)) was not significantly different than the mean of those who used this workaround (\(\bar{x} = 88.8, s = 35.1\)).

**H\(_0\):** There is no relationship between level of *Workaround Usage* and administering a new medication before verifying the new medication order, as measured by the *WUSBIN*. 
Hₐ: There is a relationship between level of *Workaround Usage* and administering a new medication before verifying the new medication order, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *Workaround Usage* and administering a new medication before verifying the new medication order, did not find a significant difference between the means of the two groups (*t*(78) = -.685, *p* > .05). The *Workaround Usage* mean (\( \bar{x} = 86.5, s = 14.6 \)) was not significantly different than the mean of those who used this workaround (\( \bar{x} = 89.1, s = 17.5 \)).

H₀: There is no relationship between level of *Workaround Usage* and administering a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

Hₐ: There is a relationship between level of *Workaround Usage* and administering a medication to a patient without scanning their ID band (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *Workaround Usage* and administering a medication without scanning the patient ID band did not find a significant difference between the means of the two groups (*t*(78) = 1.585, *p* > .05). The *Workaround Usage* mean (\( m = 85.1, s = 15.2 \)) was not significantly different than the mean of those who used this workaround (\( m = 89.6, s = 15.4 \)).

H₀: There is no relationship between level of *Workaround Usage* and administering a medication to a patient without scanning the medication barcode (does not include unsuccessful scanning attempts), as measured by the WUSBIN.
Hₐ: There is a relationship between level of Workaround Usage and administering a medication to a patient without scanning the medication barcode (does not include unsuccessful scanning attempts), as measured by the WUSBIN.

The independent t-test comparing the mean scores of Workaround Usage and administering a medication without scanning the medication barcode did not find a significant difference between the means of the two groups (t(78) = -.577, p > .05). The Workaround Usage mean (\(\bar{x} = 86.5, s = 15.7\)) was not significantly different than the mean of those who used this workaround (\(\bar{x} = 88.6, s = 14.9\)).

H₀: There is no relationship between level of Workaround Usage and scanning a patient ID code from another object not on the patient, as measured by the WUSBIN.

Hₐ: There is a relationship between level of Workaround Usage and scanning a patient ID code from another object not on the patient, as measured by the WUSBIN.

The independent t-test comparing the mean scores of Workaround Usage and scanning a patient ID code from another object not on the patient did not find a significant difference between the means of the two groups (t(78) = -1.033, p > .05). The Workaround Usage mean (\(\bar{x} = 86.1, s = 15.5\)) was not significantly different than the mean of those who used this workaround (\(\bar{x} = 90.0, s = 15.0\)).

H₀: There is no relationship between level of Workaround Usage and scanning the medication barcode after the barcode label has been removed from the medication itself, as measured by the WUSBIN.
Hₐ: There is a relationship between level of *Workaround Usage* and scanning the medication barcode after the barcode label has been removed from the medication itself, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *Workaround Usage* and scanning the medication barcode after the barcode label has been removed from the medication itself did not find a significant difference between the means of the two groups (*t*(78) = -1.017, *p* > .05). The *Workaround Usage* mean (\(\bar{x} = 86.3, s = 15.1\)) was not significantly different than the mean of those who used this workaround (\(\bar{x} = 90.8, s = 16.8\)).

H₀: There is no relationship between level of *Workaround Usage* and scanning the medication barcode after the barcode label has been removed from the medication itself, as measured by the WUSBIN.

Hₐ: There is a relationship between level of *Workaround Usage* and scanning the medication barcode after the barcode label has been removed from the medication itself, as measured by the WUSBIN.

The independent *t*-test comparing the mean scores of *Workaround Usage* and scanning the same package multiple times when multiple packages of medication are required for the full dose, did not find a significant difference between the means of the two groups (*t*(78) = -1.445, *p* > .05). The *Workaround Usage* mean (\(\bar{x} = 84.8, s = 12.5\)) was not significantly different than the mean of those who used this workaround (\(\bar{x} = 89.7, s = 17.7\)).

Table 4.18

*Workaround Usage* and workarounds not found to be significant
<table>
<thead>
<tr>
<th>Workaround Usage</th>
<th>t-score</th>
<th>df</th>
<th>Significance (2 tailed)</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administered a medication without reviewing parameters for administration</td>
<td>0.57</td>
<td>78</td>
<td>-1.930</td>
<td>85.5</td>
<td>14.5</td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>.834</td>
<td>78</td>
<td>-.211</td>
<td>87.1</td>
<td>14.1</td>
</tr>
<tr>
<td>Reviewed a medication requiring a double check</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>.495</td>
<td>78</td>
<td>-.685</td>
<td>86.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Administered a new medication before verifying the new medication order</td>
<td>.194</td>
<td>78</td>
<td>-1.309</td>
<td>85.1</td>
<td>15.2</td>
</tr>
<tr>
<td>Administered a medication without scanning ID band</td>
<td>.566</td>
<td>78</td>
<td>-.577</td>
<td>86.5</td>
<td>15.7</td>
</tr>
<tr>
<td>Administered a medication without scanning the medication barcode</td>
<td>.305</td>
<td>78</td>
<td>-1.033</td>
<td>86.1</td>
<td>15.5</td>
</tr>
<tr>
<td>Scanned a patient ID from other object</td>
<td>.312</td>
<td>78</td>
<td>-1.017</td>
<td>86.3</td>
<td>15.1</td>
</tr>
</tbody>
</table>
Scanned the medication barcode label after it has been removed

<table>
<thead>
<tr>
<th>Workaround Usage</th>
<th>90.8</th>
<th>16.8</th>
</tr>
</thead>
</table>
Scanned the same package multiple times 89.7 17.7

4.10.3 Workaround Usage and number of workarounds used

The second hypothesis to understand this relationship

H₀: There is no relationship between Workaround Usage and the number of workarounds used, as measured by the WUSBIN.

H₁: There is a relationship between Workaround Usage and the number of workarounds used, as measured by the WUSBIN.

This hypothesis can be analyzed by considering the total number of workarounds used, which was determined by counting the total number workarounds for each nurse, as identified in the WUSBIN, survey item 48. A Pearson correlation coefficient was calculated for the relationship between Workaround Usage and the total number of workarounds used. A moderate, positive correlation was found (r(78) = .423, p < .01), indicating that as Workaround Usage increases, the total number of workarounds utilized increases. Table 4.19 illustrates this relationship.

Table 4.19

<table>
<thead>
<tr>
<th>Workaround Usage and total workarounds used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of workarounds used</td>
</tr>
</tbody>
</table>

130
4.11 The relationship between BCMA Satisfaction and Workaround Usage with study demographic variables

In order to fully understand the impact of BCMA satisfaction and the use of workarounds, it is important to evaluate how the demographics of the study population may impact satisfaction levels and workaround habits. The purpose of the last research question in this study is to discover relationships between these two main study variables and the demographics of the nurses who completed the WUSBIN.

Question 4. What is the relationship between levels of BCMA satisfaction and the workaround usage with the demographic variables of: 1) gender; 2) age; 3) highest nursing degree earned; 4) number of years employed as an RN; 5) number of years employed as an RN at the study hospital; 6) unit type; 7) employment status; 8) typical shift worked; 9) typical schedule worked; 10) self-rated computer skills; 11) presence of computer at home and; 12) self-rated skill of obtaining patient information from the study hospital computer system

This question was answered using Part III of the WUSBIN, survey items 52 through 63. For the purpose of conducting a proper analysis, the dependent variables of BCMA satisfaction and workaround usage were compared to all 12 of the demographic items (independent variables), resulting in 24 different hypotheses. For each hypothesis, the dependent variables were interval scale measures, and the independent variables were

<table>
<thead>
<tr>
<th>Workaround Usage</th>
<th>Pearson Correlation</th>
<th>Sig (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.423*</td>
<td>.000</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: *Correlation is significant at the .01 level (2-tailed)
categorical. An ANOVA F-test was used to test significance of the independent variables with the dependent variables of BCMA satisfaction and Workaround Usage. This test was used for all 24 hypotheses generated from this research question. Where significant relationships were noted, Tukey’s HSD was utilized to determine the nature of the relationship when there was more than two categories to the independent variable. This discussion will first address the relationship between BCMA Satisfaction and the study demographics, followed by a discussion of the relationships between Workaround Usage and the same demographics.

4.11.1 Relationships between BCMA Satisfaction and demographic data

The following hypothesis was tested to understand this relationship:

\[ H_0: \text{There is no relationship between BCMA satisfaction and the demographic data, as measured by the } WUSBIN. \]
\[ H_a: \text{There is a relationship between BCMA satisfaction and demographic data, as measured by the } WUSBIN. \]

Specific hypotheses which consider each demographic variable are written out here. Hypotheses are grouped to first discuss significant relationships between BCMA Satisfaction and demographic variables measured by the WUSBIN, and then those which were not found to be significant. Of the 12 hypotheses in which BCMA Satisfaction was the dependent variable and each study variable was an independent variable, six (50%) were found to have significant relationships among BCMA Satisfaction and these demographics: 1) number of years employed as a nurse; 2) number of years employed as a nurse at the study hospital; 3) unit type; 4) self-rating of computer skills; 5) having a
computer at home and 6) self-rating of skills with the hospital’s computer system. Table 4.22 and 4.23 summarize the results.

The following null hypotheses were rejected:

H₀: There is no relationship between level of *BCMA satisfaction* and the number of years employed as a nurse, as measured by the *WUSBIN*.

H₁: There is a relationship between level of *BCMA satisfaction* and the number of years employed as a nurse, as measured by the *WUSBIN*.

A one-way ANOVA was computed comparing the mean scores of *BCMA Satisfaction* and number of years employed as a nurse. A significant difference was found among the groups (*F*(8,69) = 2.842, *p* < .05). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these differences. This analysis revealed that nurses who had been employed as a nurse for 26-30 years (\(\bar{x} = 52.2, s = 25.4\)) had lower satisfaction scores than nurses who had been employed as a nurse for fewer than four years (\(\bar{x} = 77.4, s = 12.1\)), 4-5 years (\(\bar{x} = 79.2, s = 12.3\)), 6-10 years (\(\bar{x} = 76.0, s = 15.1\)), 11-15 years (\(\bar{x} = 83.6, s = 13.0\)), 31-35 years (\(\bar{x} = 81.0, s = 15.2\)) and 36 years or more (\(\bar{x} = 84.4, s = 6.8\)). Nurses who have been employed as a nurse for 16-20 years (\(\bar{x} = 73.0, s = 13.9\)) and 21-25 years (\(\bar{x} = 75.3, s = 13.6\)) were not significantly different from nurses employed as a nurse for 26-30 years. Table 4.20 provides a summary of these data. There were no other groups based on years of employment as a nurse with significant differences in *BCMA Satisfaction* scores. It should be noted that when the analysis was run using the
Harmonic Mean (7.628), the difference in means was no longer significant among groups in this category.

Table 4.20 *BCMA Satisfaction* and years employed as a nurse

<table>
<thead>
<tr>
<th>Years employed as a nurse</th>
<th>N</th>
<th>Mean BCMA Satisfaction Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4 years</td>
<td>17</td>
<td>77.4</td>
<td>12.1</td>
</tr>
<tr>
<td>4-5 years</td>
<td>11</td>
<td>79.2</td>
<td>12.3</td>
</tr>
<tr>
<td>6-10 years</td>
<td>10</td>
<td>76.0</td>
<td>15.1</td>
</tr>
<tr>
<td>11-15 years</td>
<td>7</td>
<td>83.6</td>
<td>13.0</td>
</tr>
<tr>
<td>16-20 years</td>
<td>7</td>
<td>73.0</td>
<td>13.9</td>
</tr>
<tr>
<td>21-25 years</td>
<td>6</td>
<td>75.3</td>
<td>13.6</td>
</tr>
<tr>
<td>26-30 years</td>
<td>6</td>
<td>52.2</td>
<td>25.4</td>
</tr>
<tr>
<td>31-35 years</td>
<td>9</td>
<td>81.0</td>
<td>15.2</td>
</tr>
<tr>
<td>36+ years</td>
<td>5</td>
<td>84.4</td>
<td>6.8</td>
</tr>
</tbody>
</table>

H₀: There is no relationship between level of *BCMA satisfaction* and the number of years employed as a nurse at the study hospital, as measured by the *WUSBIN*.

H₁: There is a relationship between level of *BCMA satisfaction* and the number of years employed as a nurse at the study hospital, as measured by the *WUSBIN*.

A one-way ANOVA was computed comparing the mean scores of *BCMA Satisfaction* and number of years employed as a nurse at the study hospital. A significant difference was found among the groups (*F*(8,67) = 2.357, *p* < .05). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these
differences. This analysis revealed that nurses who had been employed as a nurse at the study hospital for 26-30 years ($\bar{x} = 52.0, s = 30.0$) had lower satisfaction scores than nurses who had been employed as a nurse at the study hospital for less than four years ($\bar{x} = 78.0, s = 11.3$), 4-5 years ($\bar{x} = 83.1, s = 13.2$), 6-10 years ($\bar{x} = 80.2, s = 16.2$) and 31-35 years ($\bar{x} = 82.2, s = 16.2$). Nurses who have been employed as a nurse at the study hospital for 11-15 years ($\bar{x} = 74.1, s = 12.7$), 16-20 years ($\bar{x} = 73.2, s = 11.9$), 21-25 years ($\bar{x} = 78.2, s = 6.6$) and 36 or more years ($\bar{x} = 82.0, s = 8.5$) were not significantly different from nurses employed as a nurse at the study hospital for 26-30 years. Table 4.21 provides a summary of this data. There were no other groups based on years of employment as a nurse at the study hospital with significant differences in BCMA Satisfaction scores. It should be noted that when the analysis was run using the Harmonic Mean (5.540), the difference in means was no longer significant among groups in this category.

<table>
<thead>
<tr>
<th>Years employed as a nurse at the study hospital</th>
<th>N</th>
<th>Mean BCMA Satisfaction Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4 years</td>
<td>25</td>
<td>78.0</td>
<td>11.3</td>
</tr>
<tr>
<td>4-5 years</td>
<td>7</td>
<td>83.1</td>
<td>13.2</td>
</tr>
<tr>
<td>6-10 years</td>
<td>12</td>
<td>80.2</td>
<td>16.2</td>
</tr>
<tr>
<td>11-15 years</td>
<td>8</td>
<td>74.1</td>
<td>12.7</td>
</tr>
<tr>
<td>16-20 years</td>
<td>6</td>
<td>73.2</td>
<td>11.9</td>
</tr>
<tr>
<td>21-25 years</td>
<td>6</td>
<td>78.2</td>
<td>6.6</td>
</tr>
<tr>
<td>26-30 years</td>
<td>5</td>
<td>52.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th></th>
<th>31-35 years</th>
<th>36+ years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cases</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>82.2</td>
<td>82.0</td>
</tr>
<tr>
<td>WUSBIN Score</td>
<td>16.2</td>
<td>8.5</td>
</tr>
</tbody>
</table>

$H_0$: There is no relationship between level of *BCMA satisfaction* and unit type (inpatient or outpatient), as measured by the *WUSBIN*.

$H_a$: There is a relationship between level of *BCMA satisfaction* and unit type (inpatient or outpatient), as measured by the *WUSBIN*.

A one-way ANOVA was computed comparing the mean scores of *BCMA Satisfaction* and unit type (inpatient or outpatient). A significant difference was found among the groups ($F(1,76) = 5.560, p < .05$). Nurses working on units which were primarily inpatient ($\overline{x} = 77.8, s = 15.1$) had significantly higher *BCMA Satisfaction* scores than nurses working on primarily outpatient units ($\overline{x} = 66.3, s = 14.7$).

$H_0$: There is no relationship between level of *BCMA satisfaction* and the self-rating of computer skills as compared to peers, as measured by the *WUSBIN*.

$H_a$: There is a relationship between level of *BCMA satisfaction* and the self-rating of computer skills as compared to peers, as measured by the *WUSBIN*.

A one-way ANOVA was computed comparing the mean scores of *BCMA Satisfaction* and the self-rating of computer skills as compared to peers. A significant difference was found among the groups ($F(2,75) = 1.136, p < .05$). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these differences. This analysis revealed that nurses who self-rated their computer skills as ‘Average’ ($\overline{x} = 79.9, s = 14.2$) had significantly higher satisfaction scores than nurses who...
rated themselves as ‘Below Average’ (\(\bar{x} = 57.0, s = 30.7\)). Nurses who ranked themselves as ‘Above Average’ (\(\bar{x} = 74.1, s = 12.5\)) did not have scores which were significantly different. There were no other groups based on self-rating of computer skills with significant differences in BCMA Satisfaction scores.

\[ H_0: \text{There is no relationship between level of BCMA satisfaction} \]
\[ H_a: \text{There is a relationship between level of BCMA satisfaction} \]

A one-way ANOVA was computed comparing the mean scores of BCMA Satisfaction and having a computer at home. A significant difference was found among the groups \((F(1,75) = 17.965, p < .05)\). Nurses who use computers at home had significantly higher BCMA Satisfaction score (\(\bar{x} = 77.3, s = 13.9\)) than nurses who did not use a computer at home (\(\bar{x} = 34.5, s = 23.3\)).

\[ H_0: \text{There is no relationship between level of BCMA satisfaction and self-rating of skills with hospital computer system, as measured by the WUSBIN.} \]
\[ H_a: \text{There is a relationship between level of BCMA satisfaction and self-rating of skills with the hospital computer system, as measured by the WUSBIN.} \]

A one-way ANOVA was computed comparing the mean scores of BCMA Satisfaction and self-rating of skills with the hospital computer system. A significant difference was found among the groups \((F(3,75) = 7.258, p < .05)\). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these differences. This
analysis revealed that nurses who rated their skills with the hospital computer system as ‘Poor’ had significantly lower satisfactions scores ($\bar{x} = 34.5$, $s = 23.3$) than nurses who rated themselves as ‘Good’ ($\bar{x} = 77.6$, $s = 11.4$) or ‘Excellent’ ($\bar{x} = 78.3$, $s = 15.9$). Nurses who rated themselves as ‘Fair’ ($\bar{x} = 63.7$, $s = 16.8$) did not have scores which were significantly different. There were no other groups based on self-rating of skills with the hospital computer system with significant differences in BCMA Satisfaction scores.

Table 4.22 BCMA Satisfaction and significant demographic relationships

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df</th>
<th>Significance (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA Satisfaction</td>
<td>2.842</td>
<td>8,69</td>
<td>.009</td>
</tr>
<tr>
<td>Years employed as a nurse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>2.357</td>
<td>8,67</td>
<td>.027</td>
</tr>
<tr>
<td>Years employed as a nurse at the study hospital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>5.560</td>
<td>1,76</td>
<td>.021</td>
</tr>
<tr>
<td>Unit type (inpatient/outpatient)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>5.110</td>
<td>2,75</td>
<td>.008</td>
</tr>
</tbody>
</table>
Self-rating of computer skills compared to peers

| BCMA Satisfaction | 17.965 | 1.75 | .000 |

Has a computer at home

| BCMA Satisfaction | 7.258 | 3.75 | .000 |

Self-rating of skills with hospital computer system

The following null hypotheses failed to be rejected because no significant relationships were found. The demographic variables which did not have significant relationships with BCMA Satisfaction are: 1) gender; 2) age; 3) highest nursing degree; 4) employment status; 5) shift rotation; 6) typical weekly schedule.

H₀: There is no relationship between level of BCMA satisfaction and gender, as measured by the WUSBIN.

Hₐ: There is a relationship between level of BCMA satisfaction and gender, as measured by the WUSBIN.

The BCMA Satisfaction scores of nurses completing the WUSBIN were compared by gender using a one-way ANOVA. No significant differences were found among the groups ($F(1,77) = 2.616, p > .05$).

H₀: There is no relationship between level of BCMA satisfaction and age, as measured by the WUSBIN.

Hₐ: There is a relationship between level of BCMA satisfaction and age, as measured by the WUSBIN.
The BCMA Satisfaction scores of nurses completing the WUSBIN were compared by age using a one-way ANOVA. No significant differences were found among the groups \( F(4,74) = .589, \ p > .05 \).

**H₀:** There is no relationship between level of BCMA satisfaction and highest nursing degree, as measured by the WUSBIN.

**H₁:** There is a relationship between level of BCMA satisfaction and highest nursing degree, as measured by the WUSBIN.

The BCMA Satisfaction scores of nurses completing the WUSBIN were compared by highest nursing degree using a one-way ANOVA. No significant differences were found among the groups \( F(3,75) = 1.513, \ p > .05 \).

**H₀:** There is no relationship between level of BCMA satisfaction and employment status (full-time, part-time and per diem), as measured by the WUSBIN.

**H₁:** There is a relationship between level of BCMA satisfaction and employment status (full-time, part-time and per diem), as measured by the WUSBIN.

The BCMA Satisfaction scores of nurses completing the WUSBIN were compared by employment status (full-time, part-time and per diem) using a one-way ANOVA. No significant differences were found among the groups \( F(2,75) = 2.268, \ p > .05 \).

**H₀:** There is no relationship between level of BCMA satisfaction and shift rotation schedule, as measured by the WUSBIN.
Hₐ: There is a relationship between level of BCMA satisfaction and shift rotation schedule, as measured by the WUSBIN.

The BCMA Satisfaction scores of nurses completing the WUSBIN were compared by shift rotation schedule using a one-way ANOVA. No significant differences were found among the groups ($F(6,71) = .795, p > .05$).

H₀: There is no relationship between level of BCMA satisfaction and typical weekly schedule, as measured by the WUSBIN.

Hₐ: There is a relationship between level of BCMA satisfaction and typical weekly schedule, as measured by the WUSBIN.

The BCMA Satisfaction scores of nurses completing the WUSBIN were compared by typical weekly schedule using a one-way ANOVA. No significant differences were found among the groups ($F(2,75) = 1.136, p > .05$).

Table 4.23 BCMA Satisfaction and Demographics without significant relationships

<table>
<thead>
<tr>
<th></th>
<th>$F$</th>
<th>Df</th>
<th>Significance (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA Satisfaction</td>
<td>2.616</td>
<td>1,77</td>
<td>.110</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>.589</td>
<td>4,74</td>
<td>.672</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>1.513</td>
<td>3,75</td>
<td>.218</td>
</tr>
<tr>
<td>Highest Nursing Degree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### BCMA Satisfaction

Employment Status (full-time, part-time, per diem)

<table>
<thead>
<tr>
<th></th>
<th>Mean 1</th>
<th>Mean 2</th>
<th>Mean 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA Satisfaction</td>
<td>2.268</td>
<td>2.75</td>
<td>.111</td>
</tr>
</tbody>
</table>

Shift Rotation Schedule

<table>
<thead>
<tr>
<th></th>
<th>Mean 1</th>
<th>Mean 2</th>
<th>Mean 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA Satisfaction</td>
<td>.795</td>
<td>6.71</td>
<td>.577</td>
</tr>
</tbody>
</table>

Typical weekly schedule

---

#### 4.11.2 Relationships between Workaround Usage and demographic data

The following hypothesis was tested to understand this relationship:

- $H_0$: There is no relationship between Workaround Usage and the demographic data, as measured by the WUSBIN.
- $H_a$: There is a relationship between Workaround Usage and demographic data, as measured by the WUSBIN.

Of the 12 hypotheses in which Workaround Usage was the dependent variable and each study variable was an independent variable, four (33%) were found to have significant relationships. Significant relationships were found among Workaround Usage and these demographics: 1) number of years employed as a nurse; 2) number of years employed as a nurse at the study hospital; 3) having a computer and home; and 4) self-rating of skills with the hospital’s computer system. Table 4.26 and 4.27 summarize the results.
$H_0$: There is no relationship between level of \textit{Workaround Usage} and the number of years employed as a nurse, as measured by the \textit{WUSBIN}.

$H_a$: There is a relationship between level of \textit{Workaround Usage} and the number of years employed as a nurse, as measured by the \textit{WUSBIN}.

A one-way ANOVA was computed comparing the mean scores of \textit{Workaround Usage} and number of years employed as a nurse. A significant difference was found among the groups ($F(8,69) = 2.227, p < .05$). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these differences. This analysis revealed that nurses who had been employed as a nurse for 26-30 years ($\bar{x} = 107.7, s = 21.4$) had higher workaround scores than nurses who had been employed as a nurse for 4-5 years ($\bar{x} = 82.8, s = 10.6$) and 6-10 years ($\bar{x} = 80.3, s = 11.9$). Nurses who have been employed as a nurse for less than four years ($\bar{x} = 90.1, s = 15.5$), 11-15 years ($\bar{x} = 84.3, s = 21.7$), 16-20 years ($\bar{x} = 81.7, s = 9.5$), 21-25 years ($\bar{x} = 92.0, s = 14.2$), 31-35 years ($\bar{x} = 87.2, s = 12.3$) and 36 years or more ($\bar{x} = 84.4, s = 12.1$) were not significantly different from nurses employed as a nurse for 26-30 years. There were no other groups based on years of employment as a nurse with significant differences in \textit{Workaround Usage} scores.

Table 4.24 \textit{Workaround Usage} and years employed as a nurse

<table>
<thead>
<tr>
<th>Years employed as a nurse</th>
<th>N</th>
<th>Mean \textit{Workaround Usage Score}</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4 years</td>
<td>17</td>
<td>90.1</td>
<td>15.5</td>
</tr>
<tr>
<td>4-5 years</td>
<td>11</td>
<td>82.8</td>
<td>10.6</td>
</tr>
<tr>
<td>6-10 years</td>
<td>10</td>
<td>80.3</td>
<td>11.9</td>
</tr>
</tbody>
</table>
H₀: There is no relationship between level of Workaround Usage and the number of years employed as a nurse at the study hospital, as measured by the WUSBIN.

H₁: There is a relationship between level of Workaround Usage and the number of years employed as a nurse at the study hospital, as measured by the WUSBIN.

A one-way ANOVA was computed comparing the mean scores of Workaround Usage and number of years employed as a nurse at the study hospital. A significant difference was found among the groups ($F(8,67) = 2.137, p < .05$). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these differences. This analysis revealed that nurses who had been employed as a nurse for 26-30 years ($\bar{x} = 102.2, s = 27.2$) had higher workaround scores than nurses who had been employed as a nurse for 6-10 years ($\bar{x} = 74.8, s = 14.9$). Nurses who have been employed as a nurse for fewer than four years ($\bar{x} = 87.8, s = 14.1$), 4-5 years ($\bar{x} = 87.3, s = 10.5$), 11-15 years ($\bar{x} = 93.6, s = 13.5$), 16-20 years ($\bar{x} = 82.2, s = 11.4$), 21-25 years ($\bar{x} = 90.7, s = 11.1$), 31-35 years ($\bar{x} = 82.6, s = 14.0$) and 36 years or more ($\bar{x} = 88.5, s = 10.6$) were not significantly different from nurses employed as a nurse for 26-30 years. Table 4.25

<table>
<thead>
<tr>
<th>Years</th>
<th>Nurses</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-15 years</td>
<td>7</td>
<td>84.3</td>
<td>21.7</td>
</tr>
<tr>
<td>16-20 years</td>
<td>7</td>
<td>81.7</td>
<td>9.5</td>
</tr>
<tr>
<td>21-25 years</td>
<td>6</td>
<td>92.0</td>
<td>14.2</td>
</tr>
<tr>
<td>26-30 years</td>
<td>6</td>
<td>107.7</td>
<td>21.4</td>
</tr>
<tr>
<td>31-35 years</td>
<td>9</td>
<td>87.2</td>
<td>12.3</td>
</tr>
<tr>
<td>36+ years</td>
<td>5</td>
<td>84.4</td>
<td>12.1</td>
</tr>
</tbody>
</table>

Table 4.25
provides a summary of this data. There were no other groups based on years of employment as a nurse with significant differences in Workaround Usage scores.

Table 4.25 Workaround Usage and years employed as a nurse at the study hospital

<table>
<thead>
<tr>
<th>Years employed as a nurse at the study hospital</th>
<th>N</th>
<th>Mean Workaround Usage Score</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4 years</td>
<td>25</td>
<td>87.8</td>
<td>14.1</td>
</tr>
<tr>
<td>4-5 years</td>
<td>7</td>
<td>87.3</td>
<td>10.5</td>
</tr>
<tr>
<td>6-10 years</td>
<td>12</td>
<td>74.8</td>
<td>14.9</td>
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<tr>
<td>11-15 years</td>
<td>8</td>
<td>96.3</td>
<td>13.5</td>
</tr>
<tr>
<td>16-20 years</td>
<td>6</td>
<td>82.2</td>
<td>11.4</td>
</tr>
<tr>
<td>21-25 years</td>
<td>6</td>
<td>90.7</td>
<td>11.1</td>
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<tr>
<td>26-30 years</td>
<td>5</td>
<td>102.2</td>
<td>27.2</td>
</tr>
<tr>
<td>31-35 years</td>
<td>5</td>
<td>82.6</td>
<td>14.0</td>
</tr>
<tr>
<td>36+ years</td>
<td>2</td>
<td>88.5</td>
<td>10.6</td>
</tr>
</tbody>
</table>

H₀: There is no relationship between level of Workaround Usage having a computer at home, as measured by the WUSBIN.
H₁: There is a relationship between level of Workaround Usage and having a computer at home, as measured by the WUSBIN.

A one-way ANOVA was computed comparing the mean scores of Workaround Usage and having a computer at home. A significant difference was found among the groups \((F(1,75) = 9.200, p < .05)\). Nurses who use computers at home had significantly lower Workaround Usage score \((\bar{x} = 86.4, s = 14.6)\) than nurses who did not use a computer at home \((\bar{x} = 118.5, s = 27.6)\).

H₀: There is no relationship between level of Workaround Usage and self-rating of skills with hospital computer system, as measured by the WUSBIN.

H₁: There is a relationship between level of Workaround Usage and self-rating of skills with the hospital computer system, as measured by the WUSBIN.

A one-way ANOVA was computed comparing the mean scores of Workaround Usage and self-rating of skills with the hospital computer system. A significant difference was found among the groups \((F(3,75) = 6.919, p < .05)\). In order to understand this relationship in greater detail, Tukey’s HSD was used to determine the nature of these differences. This analysis revealed that nurses who rated their skills with the hospital computer system as ‘Poor’ had significantly higher workaround scores \((\bar{x} = 118.5, s = 27.6)\) than nurses who rated themselves as ‘Good’ \((\bar{x} = 85.9, s = 12.5)\) or ‘Excellent’ \((\bar{x} = 84.6, s = 14.6)\). Nurses who rated themselves as ‘Fair’ \((\bar{x} = 111.7, s = 19.9)\) did not have scores that were significantly different. Nurses who rated themselves as ‘Fair’ \((\bar{x} = 111.7, s = 19.9)\); however, had workaround scores that were significantly higher than nurses who rated
themselves as ‘Good’ ($\bar{x} = 85.9, s = 12.5$) or ‘Excellent’ ($\bar{x} = 84.6, s = 14.6$). There were no other groups based on self-rating of skills with the hospital computer system with significant differences in Workaround Usage scores.

Table 4.26 Workaround Usage and significant demographic relationships

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Df</th>
<th>Significance (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCMA Satisfaction</td>
<td>2.227</td>
<td>8,69</td>
<td>.036</td>
</tr>
<tr>
<td>Years employed as a nurse</td>
<td>2.137</td>
<td>8,67</td>
<td>.044</td>
</tr>
<tr>
<td>Years employed as a nurse at the study hospital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCMA Satisfaction</td>
<td>9.200</td>
<td>1,75</td>
<td>.003</td>
</tr>
<tr>
<td>Has a computer at home</td>
<td>6.919</td>
<td>3,75</td>
<td>.000</td>
</tr>
<tr>
<td>Self-rating of skills with hospital computer system</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following null hypotheses failed to be rejected because no significant relationships were found. The demographic variables which did not have significant relationships with BCMA Satisfaction are: 1) gender; 2) age; 3) highest nursing degree;
4) unit type; 5) employment status; 6) shift rotation; 7) typical weekly schedule and 8) self-rated computer skills compared to peers.

H₀: There is no relationship between level of Workaround Usage and gender, as measured by the WUSBIN.

H₁: There is a relationship between level of Workaround Usage and gender, as measured by the WUSBIN.

The Workaround Usage scores of nurses completing the WUSBIN were compared by gender using a one-way ANOVA. No significant differences were found among the groups ($F(1,77) = .410, p > .05$).

H₀: There is no relationship between level of Workaround Usage and age, as measured by the WUSBIN.

H₁: There is a relationship between level of Workaround Usage and age, as measured by the WUSBIN.

The Workaround Usage scores of nurses completing the WUSBIN were compared by age using a one-way ANOVA. No significant differences were found among the groups ($F(4,74) = 1.369, p > .05$).

H₀: There is no relationship between level of Workaround Usage and highest nursing degree, as measured by the WUSBIN.

H₁: There is a relationship between level of Workaround Usage and highest nursing degree, as measured by the WUSBIN.
The Workaround Usage scores of nurses completing the WUSBIN were compared by highest nursing degree using a one-way ANOVA. No significant differences were found among the groups ($F(3,75) = 1.325, p > .05$).

$H_0$: There is no relationship between level of Workaround Usage and unit type (inpatient or outpatient), as measured by the WUSBIN.

$H_a$: There is a relationship between level of Workaround Usage and unit type (inpatient or outpatient), as measured by the WUSBIN.

The Workaround Usage scores of nurses completing the WUSBIN were compared by unit type (inpatient or outpatient) using a one-way ANOVA. No significant differences were found among the groups ($F(2,75) = .059, p > .05$).

$H_0$: There is no relationship between level of Workaround Usage and employment status (full-time, part-time and per diem), as measured by the WUSBIN.

$H_a$: There is a relationship between level of Workaround Usage and employment status (full-time, part-time and per diem), as measured by the WUSBIN.

The Workaround Usage scores of nurses completing the WUSBIN were compared by employment status (full-time, part-time and per diem) using a one-way ANOVA. No significant differences were found among the groups ($F(2,75) = .076, p > .05$).

$H_0$: There is no relationship between level of Workaround Usage and shift rotation schedule, as measured by the WUSBIN.
Hₐ: There is a relationship between level of *Workaround Usage* and shift rotation schedule, as measured by the *WUSBIN*.

The *Workaround Usage* scores of nurses completing the *WUSBIN* were compared by shift rotation schedule using a one-way ANOVA. No significant differences were found among the groups ($F(6,71) = 1.029, p > .05$).

Hₒ: There is no relationship between level of *Workaround Usage* and typical weekly schedule, as measured by the *WUSBIN*.

Hₐ: There is a relationship between level of *Workaround Usage* and typical weekly schedule, as measured by the *WUSBIN*.

The *Workaround Usage* scores of nurses completing the *WUSBIN* were compared by typical weekly schedule using a one-way ANOVA. No significant differences were found among the groups ($F(2,75) = 2.146, p > .05$).

Hₒ: There is no relationship between level of *Workaround Usage* and self-rating of computer skills, as measured by the *WUSBIN*.

Hₐ: There is a relationship between level of *Workaround Usage* and self-rating of computer skills, as measured by the *WUSBIN*.

The *Workaround Usage* scores of nurses completing the *WUSBIN* were compared by self-rating of computer skills using a one-way ANOVA. No significant differences were found among the groups ($F(2,75) = .904, p > .05$).
Table 4.27 Workaround Usage and Demographics without significant relationships

<table>
<thead>
<tr>
<th></th>
<th>$F$</th>
<th>Df</th>
<th>Significance (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workaround Usage</td>
<td>.410</td>
<td>1.77</td>
<td>.524</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>1.369</td>
<td>4.74</td>
<td>.253</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>1.325</td>
<td>3.75</td>
<td>.273</td>
</tr>
<tr>
<td>Highest Nursing Degree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>.059</td>
<td>1.76</td>
<td>.808</td>
</tr>
<tr>
<td>Unit Type (inpatient or ourpatient)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>.076</td>
<td>2.75</td>
<td>.927</td>
</tr>
<tr>
<td>Employment Status (full-time, part-time, per diem)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Workaround Usage</td>
<td>1.029</td>
<td>6.71</td>
<td>.414</td>
</tr>
<tr>
<td>Shift Rotation Schedule</td>
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4.12 Summary

Chapter 4 reported the data analysis for this research study. A discussion of the pilot study began the chapter, followed by the changes made in the WUSBIN as a result of the pilot. The study sample and demographic characteristics were described next. An in-depth report of the statistics which describe the main study variables of BCMA Satisfaction and Workaround Usage began the data analysis discussion, followed by details noted in the content analysis of the comments made in the WUSBIN by study subjects. Lastly, a description of the statistical tests used to answer research questions 1-4 was provided. Statistical tests in this study included Pearson’s Correlation Coefficient, independent t-tests, ANOVA and Tukey’s HSD for post-hoc analysis. Significant relationships were found between the following study variables: BCMA Satisfaction and Workaround Usage; BCMA Satisfaction and Perceived Ease of Use; Workaround Usage and Perceived Ease of Use and Workaround Usage and Perceived Usefulness. Significant relationships were also noted between BCMA Satisfaction and six different types of workarounds, as well as Workaround Usage and five different types of workarounds. The number of different workarounds a nurse uses was also found to be positively related to BCMA Satisfaction and Workaround Usage. Demographic
characteristics of the study population had six significant relationships with BCMA Satisfaction and four with Workaround Usage.
5.1 Overview of Study

Quality of care and patient safety are among healthcare’s greatest current priorities (IOM, 1999). Tighter processes and policies are introduced into healthcare facilities every day to ensure this priority is addressed. This requires healthcare professionals to change their thinking and working habits in order to keep patients safe from harm. To ensure that the highest level of quality and safety is met, many of these changes provide improvements to or are new developments in technology. Practices related to patient medication are those which are at greatest risk for error and adverse outcomes (IOM, 1999). The nursing profession is particularly concerned with medication safety for patients, especially during medication administration. In an attempt to improve safety during this process, healthcare has moved to utilizing technology to enhance patient safety during medication administration. The transformation from a traditional, manual medication administration process to one which utilizes a barcoding system to ensure safety has created a variety of responses by nurses. Nurse satisfaction with barcode medication administration (BCMA) and nurse utilization of workarounds related to medication administration are two issues which have recently been explored in the current nursing literature and were the two variables of focus in this nursing research study (Fowler et al., 2009; Halbesleben et al., 2010; Halbesleben, 2010a; Halbesleben, 2010b; Hurley et al., 2007; Hurley et al., 2008; Koppel et al., 2008; Morriss et al., 2009; Patterson et al., 2006; Tremblay, 2010; Van Onzenoort et al., 2008; Vogelsmeier et al., 2008;).
The purpose of this study was to understand the relationship between registered nurse (RN) satisfaction, also known as end-user acceptance, with their BCMA system, Perceived Usefulness (PU), Perceived Ease of Use (PEOU) and RN BCMA workaround usage. The Technology Acceptance Model (TAM) was used as a framework to understand the relationship (Alrafi, 2005). This chapter will discuss the study findings, beginning with the descriptive statistics related to BCMA Satisfaction and Workaround Usage, the appropriateness of the TAM, and the outcomes of the exploratory analysis for each research question. Study limitations, implications for nursing practice, informatics, education and administration and recommendations for future nursing research will also be discussed.

5.2 Descriptive findings regarding Barcode Medication Administration (BCMA) Satisfaction

Overall, nurses in this study were satisfied with the BCMA system at the study hospital. More nurses described their satisfaction level as either being moderate or moderately-high. Nurses’ overall rating of the system was positively correlated to their actual BCMA Satisfaction Score. This indicates that their initial general rating of the system was fairly consistent with the score generated by their more detailed analysis of the system.

While nurses indicated that they were satisfied with the system overall, most of the comments provided by subjects at the end of the survey were not necessarily indicative of satisfaction with the system. In fact, only a small number of comments were completely positive. Most nurses either complained about the system’s shortcomings or made mixed comments implying that they liked the idea of a BCMA system,
but felt there were too many faults in the system they used. The varied nature of the comments provided by subjects may explain the reason why satisfaction scores were generally moderate to moderately high, as opposed to high. Despite that BCMA systems are intended to make medication administration safer, nurses would be more satisfied if the system had fewer faults. In their study, Morriss and colleagues (2009) also found that nurses had mixed feelings about the BCMA system. Hurley and colleagues (2007) also found that nurses were very satisfied with their BCMA system based on BCMA scores, but many of the comments noted by this research team were not always completely positive, with study participants expressing concerns similar to the subjects in this study.

5.3 Descriptive findings regarding Workaround Usage

Workaround usage, as measured in this study, was found to be moderately low. In most instances, the nurses in this study did their best to follow medication administration policy and procedure. The most common type of workaround which nurses admitted to using was related to scanning the same package multiple times when multiple packages were required. This is an unauthorized BCMA process step and creates a risk related to administering the wrong medication or dose (Koppel et al., 2008). Nurses should be scanning each individual package required to make up the dose, so they do not accidently give the patient the wrong drug or miscount and administer the incorrect quantity of pills. The next most common workaround involved administering medications without actually scanning the patient’s identification band. One nurse in this study commented that she does not wake patients up to just hang a new IV bag, while another nurse noted that when she is in a hurry to administer a medication, such as something for pain, she also does not take the time to scan the patient before giving the
medication. These behaviors put the nurse at risk for administering the medication to the wrong patient and are considered an omission of a process step (Koppel et al., 2008). The third most common workaround which nurses admitted to using was documenting that a medication was administered before it actually was given or when the patient ingested it. This type of workaround performs steps out of sequence and risks omitting a medication that the patient needs or not administering a medication as documented (Koppel et al., 2008). Medication administration of oral medications should not be documented until the patient has ingested the medication.

Interestingly, the same three workarounds described above, as the workarounds which the most nurses admitted to using were also the three most common workarounds which nurses stated they also used the most often; however the order was slightly modified. Scanning the same package numerous times was the workaround which nurses indicated they used the most often, but documenting a medication before it was actually administered or ingested was the second most commonly used workaround, and not scanning the patient’s identification band was noted to be the third most common workaround used. It is possible that this occurred because people did not understand the difference between the two questions, as they were worded similarly and had the same list of workarounds as possible answer options to each of the respective questions. This potential problem was identified during the study’s pilot process, resulting in changes to the question root so these questions would not appear to be identical. Despite this change, it is possible that study participants still made this mistake. The two survey items which asked nurses to identify which workarounds they have ever used and which workarounds they used most often, were near the end of the survey. It is possible that
study participants were growing tired by the time they reached these survey items, which could have resulted in their misreading of the items. It is also just possible that the workarounds which nurses use the most often was the same as the ones that most nurses admitted to using because they (workarounds) are so common.

5.4 Descriptive findings regarding Perceived Ease of Use (PEOU) and Perceived Usefulness (PU)

Nurse perceptions related to how easy it is to use (PEOU) and how useful (PU) the system is, were widely dispersed; however, the overall theme related to these perceptions was that nurses felt the system was easy to use, yet it was not very useful. This theme is best supported by the comments made by the nurses in this study. The majority of the comments expressed concerns or issues with the system, describing why it is not useful. Usage problems with BCMA requirements were prevalent, specifically related to the wireless connection, medications and equipment. Several comments implied that the system would be much more useful if these problems were fixed. This finding is concerning because PU is more closely linked to technology usage than PEOU (Davis, 1989). In most cases, if people do not find a technology to be useful, they are not likely to use it (Davis, 1989). Since the study hospital chooses to use a BCMA system, the only alternative staff has to using the system is employing workarounds if they find the system itself to be useless.

5.5 Application of The Technology Acceptance Model to this study

The Technology Acceptance Model (TAM) was the guiding framework for this study. It addresses how users are able to accept and use technology (Alrafi, 2005). In this study, users were RNs and the technology was BCMA. According to the TAM, RN satisfaction with the BCMA system (BCMA Satisfaction) is the greatest predictor of
whether the RN will utilize workarounds (*Workaround Usage*) (Holden & Karsh, 2010). BCMA satisfaction is determined by how easy the BCMA system (*PEOU*) is to use and how useful (*PU*) the RN finds the system (Alrafi, 2005). See Figure 5.1 for a diagram of this relationship.

![Figure 5.1 Application of the TAM to study variables](image)

This model was useful for framing this study, as most of the relationships among study variables were significant. The use of the model highlights the concern that the nurses in this study find their BCMA system easy to use (*PEOU*), but they do not consider it to be useful (*PU*). Since *PU* has a greater impact on nurse attitude towards the BCMA system than *PEOU*, perceptions of BCMA usefulness may impact RN usage of workarounds. If nurses have a negative attitude toward the BCMA system, they are less likely to be satisfied with it and therefore, are more likely to use workarounds. Efforts towards improving how useful nurses find the BCMA system should reduce workaround usage, increasing the level of patient safety during medication administration.
5.6 The relationship between BCMA Satisfaction and Workaround Usage

Pearson’s correlation coefficient was used to analyze the relationship between BCMA Satisfaction and Workaround Usage (Research Question 1). A moderately strong negative relationship was found between BCMA Satisfaction and Workaround Usage, indicating that as satisfaction with the BCMA system increases, workaround usage decreases. This means that the more satisfied nurses are with the BCMA system, the less likely they are to use workarounds. This is an important discovery because to date, measures of actual workaround usage are underdeveloped and inconsistent (Halbesleben, 2008). Measuring workaround usage is a sensitive subject because nurses are often blamed for circumventing safety rules when utilizing workarounds (Koppel et al., 2008). Since higher satisfaction scores can be linked to lower workaround usage, it may be less threatening to measure nurse satisfaction with a BCMA system than it is to measure workaround usage directly. Nurses may be less defensive when answering questions regarding their satisfaction with the system than questions which may imply that they are cheating the system. Until workaround measures are more developed and more consistently used, measuring BCMA Satisfaction may be the best alternative. In addition, if BCMA Satisfaction is measured using the MAS-NAS in its entirety, survey respondents will have the chance to provide written comments to help clarify issues related to satisfaction, which may reflect on workaround usage.

5.7 The relationship between BCMA Satisfaction and PEOU and PU

The Pearson’s Correlation Coefficient was used to analyze the relationship between BCMA Satisfaction and PEOU, as well as between BCMA Satisfaction and PU (Research Question 2). Interestingly, a strong relationship was found between BCMA Satisfaction and PEOU, yet no relationship was found between BCMA Satisfaction and
This difference is likely related to the previously mentioned finding that nurses in this study only found the system to be easy to use, but not useful. *PEOU* has been documented as an important factor in influencing user acceptance, also known as user satisfaction (Venkatesh, 2000). Easy use of the system may promote satisfaction. As noted in the comments made by study nurses, many nurses have mixed feelings about their BCMA system; however, overall satisfaction scores and BCMA Satisfaction scores were generally positive. This supports that while nurses may not always find the system to be useful, they may still describe themselves as satisfied with the system. This may mean that system usefulness is not strong enough to predict levels of satisfaction among nurses. Davis (1989) notes that *PEOU* and *PU* are subjective measures of performance and effort and may not necessarily reflect an objective reality. The measures of BCMA Satisfaction, *PU* and *PEOU* are all subjective in this study, as they are self-reported; therefore, the relationship as it is predicted here could be inaccurate. Based on the mixed nature of the comments made in this survey, it is probable that study nurses are quite satisfied with the idea of BCMA and are even satisfied with the system when it works. Their perceptions of uselessness likely stem from the problems they described that they encountered on a daily basis, not from the system itself. Nurses expressed frustration when they lost connectivity, when patient identification barcodes were printed too lightly and could not be read by the scanners, and when the scanners simply did not work correctly. For these reasons the nurses find the system useless because it impedes their workflow. Problems with the system are random and unpredictable. This may explain why subjects’ low levels of PU are not correlated with levels of satisfaction.
5.8 The relationship between BCMA Satisfaction and types of workarounds used

The independent t-test was used to measure the relationship between BCMA Satisfaction and 13 different types of workarounds (Research Question 2). Six significant relationships were found. In these cases, nurses with lower levels of satisfaction were more likely to use these workarounds than nurses with higher levels of satisfaction. As described above, nurses in this study do not perceive their BCMA system to be useful, and when nurses operate under this perception, they are not likely to use the system as intended (Davis, 1989). For this reason, nurses may feel forced to utilize workarounds in order to get their work done. Scanning a medication from the patient drawer without a visual check and administering medication without reviewing parameters are considered to be workarounds which omit process steps (Koppel et al., 2008). The remaining workarounds are considered to be unauthorized BCMA process steps (Koppel et al., 2008). If nurses do not perceive the system to be useful, they may feel forced into omitting steps and utilizing unauthorized steps in order to complete their work, which could cause them to be dissatisfied with the system. The other seven workarounds that were compared to BCMA Satisfaction scores were not found to have a significant relationship.

5.9 The relationship between BCMA Satisfaction and total number of workarounds used

A Pearson’s Correlation Coefficient was used to analyze the relationship between BCMA Satisfaction and total number of workarounds used by each nurse (Research Question 2). A weak positive relationship was found, indicating that as BCMA Satisfaction levels increase, the number of total workarounds decreases. In other words, nurses who are less satisfied with the BCMA system use more total workarounds than
nurses who are more satisfied with the system. As described above, there are six workarounds which nurses with lower levels of satisfaction are likely to use, indicating that these nurses use more workarounds than nurses who are more satisfied. Workaround usage is seen as a problem-solving strategy; therefore, they may become routine in some healthcare organizations, becoming an automatic process (Halbesleben, 2008; Tucker & Edmondson, 2002). As stated above, if nurses are accustomed to using workarounds, they may view their usage as necessary to get their work done, which can impact their satisfaction with the system.

5.10 The relationship Workaround Usage and PEOU and PU

The Pearson’s Correlation Coefficient was used to analyze the relationship between Workaround Usage and PEOU, as well as between Workaround Usage and PU (Research Question 3). A very strong positive correlation was noted between Workaround Usage and PEOU, indicating that as Workaround Usage decreases, PEOU increases, based on the scoring scales. Additionally, a moderate correlation was noted between Workaround Usage and PU, indicating that as Workaround Usage decreases, PU increases, based on the scoring scales. Both PEOU and PU are an important factors in influencing usage behavior (Davis, 1989; Venkatesh, 2000). Since this study found that nurses perceive the system to be easy to use, but not necessarily useful, usage of workarounds is likely to vary. The strong correlation to PEOU and the moderate correlation to PU may explain the moderately low overall Workaround Usage described above.

5.11 The relationship between Workaround Usage and types of workarounds used
The independent $t$-test was used to measure the relationship between Workaround Usage and 13 different types of workarounds (Research Question 3). Five significant relationships were found. Nurses who practiced these specific workarounds were less likely overall to use workarounds in general than nurses who did not practice these specific workarounds. Some of these workarounds are the same as those described above by nurses who are less satisfied than nurses who did not use them. This stands to reason because the nurses who use these workarounds, based on lower satisfaction scores, also find the system as being less useful (PU), placing them at risk to not use the system as intended (Venkatesh, 2000). Workarounds which were the same, based on higher workaround usage scores and lower levels of satisfaction, include scanning a medication without a visual check, documenting a medication before it is actually given or completely ingested, and giving a partial dose but documenting the entire dose was given. The remaining two workarounds with significant relationships both are classified as unauthorized BCMA process steps, which risk medications being administered to the wrong patient (Koppel et al., 2008).

5.12 The relationship between Workaround Usage and total number of workarounds used

A Pearson’s Correlation Coefficient was used to analyze the relationship between Workaround Usage and total number of workarounds used by each nurse (Research Question 3). A moderate positive relationship was found, indicating that as Workaround Usage levels increase, the number of total workarounds also tends to increase. This stands to reason because the WUSBIN evaluates the use of workarounds from many different approaches and asks nurses if they would use workarounds in certain situations. The more a nurse admits to using workarounds in their practice, as described by the
WUSBIN, the greater the number of total workarounds they tend to use. Based on the WUSBIN, these workarounds may occur as omission of process steps, performing steps out of sequence and unauthorized BCMA process steps (Koppel et al., 2008). If a nurse uses workarounds in a variety of instances, they are likely to use multiple types of workarounds to complete their work.

5.1.3 The relationship between BCMA Satisfaction and the study demographic variables

An ANOVA was calculated to understand the relationship between BCMA Satisfaction and the demographic variables measured in this study (Research Question 4). Significant differences in the means of the variables and BCMA Satisfaction existed among six of the relationships, which may be helpful in identifying nurses who are at risk for workaround usage since nurses with lower levels of satisfaction are more likely to utilize workarounds. Tukey’s HSD was run to further understand the exact relationship among the variables. The other demographics measured in this study were not found to have significant relationships with BCMA Satisfaction Scores.

5.1.3.1 Years of experience in nursing (in and outside of the study hospital) and BCMA Satisfaction

Both number of years employed as a nurse (in any setting) and number of years employed as a nurse at the study hospital significantly impacted BCMA Satisfaction scores. In regards to number of years employed as a nurse in any setting, nurses with 26-30 years of experience had significantly lower BCMA Satisfaction scores than nurses in the other age categories, with the exception of those nurses with 16-20 years of experience, 21-25 years of experience, and greater than 36 years of experience. Nurses with 26-30 years of experience at the study hospital also had significantly lower mean

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BCMA Satisfaction scores than nurses with fewer than 4 years of experience, 4-5 years of experience, 6-10 years of experience and 31-35 years of experience. It is possible that nurses with 26-30 years of experience have satisfaction scores which are more similar to nurses with similar years of experience, as nurses having 10 or fewer years of experience may have different perceptions of the medication administration process, as some of them do not know a practice without BCMA and those that do have limited experience with this type of system. This rationale is questionable, however because the ANOVA found a difference in means between nurses with 26-30 years of experience and those nurses with more experience, which would not support that nurses with similar years of experience have similar satisfaction levels. It is more likely that this difference in satisfaction scores may be due to the fact that the groups were not equal in size. The Harmonic Mean was use to compare years of experience groups among these two dependent variables and the difference was no longer statistically significant in either case. There is no documentation of studies in the literature which compare levels of BCMA Satisfaction to years of experience.

5.13.2 Unit type and BCMA Satisfaction

A significant difference in BCMA Satisfaction means was noted between nurses who work in primarily inpatient or outpatient units, with nurses working in inpatient units having greater levels of satisfaction. There is a definite difference in work processes between inpatient and outpatient areas. Nurses in inpatient areas deliver medications based on a schedule, or routine medications because patients tend to be on inpatient areas for days at a time. Less often, nurses working on inpatient areas deliver medications as needed, or PRN and medications intended for a single administration, known as a one-
time order. Patients who are admitted to outpatient areas are intended to be there for hours, not days, often less than eight hours. Nurses working on an outpatient area tend to give more PRN or one-time order medications, which prompts the nurse to deliver medications when they are ordered and then available from the pharmacy, eliminating the use of a medication administration schedule. It is also fair to assume that because of the nature of these two types of units, patients on inpatient areas are generally sicker than patients on outpatient areas and therefore, require more medications. Upon further analysis of this study data, it was found that nurses working on inpatient units have significantly higher levels of Perceived Usefulness (PU) than nurses working on outpatient areas. If they find the system to be more useful, they may also be more satisfied with it; although this relationship was not found when looking at BCMA Satisfaction Score and PU scores. A more specific analysis was not conducted to look at Overall Satisfaction Scores, BCMA Satisfaction Scores or PU scores among difference demographic variables in this study. Nurses working in inpatient areas use the system more often, and use it under more controlled circumstances, such as during routine medication administration. These nurses are also more likely rely on the system more than nurses working in outpatient areas. This may contribute to their higher levels of satisfaction with the system. There is no documentation of studies in the literature which compare levels of BCMA Satisfaction among practice settings.

5.13.3 Self-rating of computer skills and BCMA Satisfaction

Nurses completing the WUSBIN were asked to rate their own computer skills as compared to the skills of their peers, using the categories of Above Average, Average and Below Average. Satisfaction scores were significantly higher among nurses who rated
themselves *Average* than nurses who rated themselves *Below Average*. Only a very small number of nurses rated themselves as *Below Average*, which could contribute to this difference, although it does stand to reason that nurses who feel they do not have strong computer skills would have lower levels of satisfaction than nurses with higher satisfaction levels. Self-confidence in using computers may help ease concerns related to computer skills. There is no documentation of studies in the literature which compare levels of *BCMA Satisfaction* to users’ self-ratings of their computer skills.

5.13.4 *Home Computer and BCMA Satisfaction*

While nearly all nurses in this study had a computer in their home, those who did not have a computer had lower *BCMA Satisfaction Scores* than those who did have a computer in their home. Nurses who do not have a computer at home likely do not use computers as often as those who do have computers at home, which would put them at risk for low levels of self-confidence with computer usage. As stated above, low levels of self-confidence may impact *BCMA Satisfaction Scores*. There is no documentation of studies in the literature which compare levels of *BCMA Satisfaction* to whether nurses have a computer at home.

5.13.5. *Self-rating of skills with hospital computer system and BCMA Satisfaction*

Lastly, nurses were asked to self-rate their ability to use the study hospital’s BCMA system. Consistent with nurses’ self-ratings of their computer skills, nurses who rated their ability to use the hospital’s system as low by using rating the rating of *Poor*, had lower BCMA Satisfaction Scores then nurses who rated themselves as *Good* or *Excellent*. Again, very few nurses rated themselves as *Poor*, which may have impacted this test, but as stated above, low rating indicates low self-confidence in the system,
which may impact *BCMA Satisfaction Scores*. There is no documentation of studies in the literature which compare levels of *BCMA Satisfaction* to self-rating skills of hospital computer systems.

5.14 The relationship between *Workaround Usage* and the study demographic variables

An ANOVA was calculated to understand the relationship between *Workaround Usage* and the demographic variables measured in this study (Research Question 4). Significant differences in the means of the variables and *Workaround Usage* existed among four of the relationships, which may be helpful in identifying nurses at risk for utilizing workarounds based on self-rating of workaround usage. These relationships are:

1) number of years employed as a nurse; 2) number of years employed as a nurse at the study hospital; 3) having a computer and home and 4) self-rating of skills with the hospital’s computer system.

5.14.1 *Years of experience in nursing (in and outside of the study hospital) and Workaround Usage*

Both number of years employed as a nurse (in any setting) and number of years employed as a nurse at the study hospital significantly impacted *Workaround Usage* scores. In regards to number of years employed as a nurse in any setting, nurses with 26-30 years of experiences had significantly higher *Workaround Usage scores* than nurses with 4-5 years of experience and 6-10 years of experience. Nurses with 26-30 years of experience at the study hospital also had significantly higher mean *Workaround Usage scores* than nurses with less than 6-10 years of experience only. Since *BCMA Satisfaction Scores* are inversely related to *Workaround Usage Scores*, it is suggestive that nurses with 26-30 years of experience have the lowest level of satisfaction with the
BCMA system, as compared to nurses with other levels of experience. As with BCMA Satisfaction Scores, when these analyses were run using Harmonic Means, differences were not significant among either of these dependent variables. So it is again possible that level of experience has no impact on workaround usage. There is no documentation of studies in the literature which compare levels of Workaround Usage to years of experience.

5.14.2. **Self-rating of skills with hospital computer system and Workaround Usage**

Nurses who have computers at home were significantly less likely to utilize workarounds than nurses who do not have computers at home. While the number of nurses who do not have computers at home is much less than those that do have computers at home, which may account for this finding, it is reasonable to assume that nurses who do not have a computer at home do not use computers as often as those who do, meaning that less exposure to computers may impact how comfortable these nurses are using computers at work. The construct of Computer Anxiety, which was measured by a subscale of the WUSBIN, is defined as one’s apprehension or fear of computers and is related to one’s general perceptions of computer usage (Venkatesh, 2000). If nurses are apprehensive about computers due to lack of experience with them, or do not have a lot of self-confidence with computers, they may be more likely to utilize workarounds as a problem-solving strategy when they are faced with a barrier to the BCMA system, as workarounds are a documented problem-solving strategy for computer barriers (Tucker & Edmondson, 2002).
5.14.3 Self-rating of skills with hospital computer system and Workaround Usage

Subjects’ self-rating of skills with the hospital’s computer system was significant for those who rated their skills as either Poor or Fair, similar to the findings for this dependent variable as it relates to BCMA Satisfaction. Those nurses with lower self-ratings had higher Workaround Usage Scores. While the number of nurses who rated themselves as either Poor or Fair is small, these nurses have higher workaround usage than nurses who rated themselves as Good or Excellent. As discussed in the previous section, computer anxiety likely plays a role in this finding. Nurses with computer anxiety tend to have negative reactions towards computers; therefore, they may develop unfavorable attitudes and behaviors towards using them (Venkatesh, 2000). For this reason, they may doubt their ability to use the hospital’s computer system.

5.15 Study Limitations

There are several limitations associated with this study. The first thing to consider is that all the data utilized in this study was self-reported, which could impact the accuracy of the data. Utilization of workarounds may be considered to be a sensitive topic to some study subjects because admitting to the utilization of workarounds implies that a nurse is breaking policy and ultimately putting patients at a great safety risk. Admittance of such behavior may be difficult. Although study participation was anonymous, it is possible that not all nurses were comfortable divulging their habits. In some cases, nurses may not recognize their own workaround behaviors. While they may perceive themselves to have honestly answered the survey questions, their responses could have been altered because they did not recognize their own practice within the survey items.
A second limit to this study is that all the data were collected within a four-week timeframe. If data had been collected over a longer time period, or at intermittent timeframes and then compared over time, a clearer picture of BCMA satisfaction and workaround usage may have been obtained. Subjects’ responses to survey items 48 and 49 were very similar. These items measured all the workarounds study subjects use and the one workaround that subjects use the most often. Pilot study participants struggled with the difference between these two items and changes were made to clarify their verbiage, but these responses may have still been confusing in the final version of the survey.

Another third study limit considers the study variables of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) that were subscales of the overall Workaround Usage Scale; therefore, these scores were derived from the overall Workaround Usage Score. Utilizing a different subscale to measure these variables and compare PEOU and PU with Workaround Usage, which is not embedded into the overall Workaround Usage scale may render different results since the scores were ultimately interrelated.

Lastly, it is unknown how well represented all clinical areas utilizing BCMA in the study hospital were because the WUSBIN only asked subjects to indicate whether they worked on an inpatient or outpatient area. It is possible that some units were not represented at all, or that some units were overrepresented. Based on the demographic variables, nurses from inpatient areas were outnumbered nurses compared to nurses from inpatient areas, which may have had an impact on study outcomes.
5.16 Implications for Nursing Practice, Informatics, Education and Administration

The implications of this study are three-fold, as the results are meaningful to those interested in nursing practice, nursing informatics, nursing education (academic and professional development) and nursing administration. These findings may help to shape nursing practice for the bedside nurse working in acute care settings. Nurses who design and implement BCMA systems should consider the findings of this study as they create and institute new systems. Nurse educators (academic and professional development) should consider these findings as they are pertinent to students or nursing staff. The findings of this study may be helpful for nurse administrators as they consider the needs of the overall healthcare organization.

5.16.1 Implications for nursing practice

The most important implications of this study are for those nurses who are providing direct patient care within the acute care setting. These are the nurses who are directly responsible for keeping patients safe and delivering quality of care. They are the final defense between patients and medication administration errors. It is imperative that these nurses understand the dangers of utilizing BCMA workarounds and the protection that a high functioning BCMA system can provide. For nurses who have been practicing for many years, making such a dramatic change how they administer medications may be stressful and difficult to manage. Nurses at all levels of experience must understand that the less satisfied they are with the system, the more likely they are to utilize workarounds. These nurses must also understand that the use of BCMA workarounds as a problem-solving strategy is unacceptable and puts their patients at risk for harm. This information can empower nurses to know that they must take action and be directly involved in the
design, integration and follow-up of a BCMA system implementation at their hospital. If nurses are not actively engaged in this process, poor systems may be developed, risking low levels of nurse satisfaction with the system, setting up a scenario for high levels of workaround usage, and ultimately resulting in fatal medication administration errors.

While there is no particular profile of the satisfied nurse or the nurse who is most likely to use workarounds, an understanding of which workarounds are most often used may help nurses to avoid using these workarounds and working with Informatic specialists to avoid such pitfalls in the integration of a BCMA system. Nurses must also collaborate with these specialists to ensure that BCMA systems are useful, as well as easy to use.

5.16.2 Implications for Nursing Informatics

Similar to practicing bedside nurses, it is important for nurses working in the field of informatics to understand the outcomes of this study. Information technology specialists who work to design BCMA systems are not necessarily nurses, as many of them are trained simply in information technology (IT), having no clinical education or training. However, they work in the healthcare field, utilizing their IT skills to create systems which are used for patient care. Nurse Informatists are obligated to ensure that these IT specialists who lack direct experience in patient care are well informed and aware of the dangers posed to patients as a result of poorly designed BCMA systems. Designing systems which ensure higher levels of satisfaction and lower levels of workaround usage must be a top priority in their work. Nurse Informatists serve as a go-between for bedside nurses and IT specialists, as they speak the language of both groups and can ensure that the priorities of each group are well represented and addressed. They have a
vantage point held by no other team member in the development, integration and
evaluation of a BCMA system into a hospital and are a crucial piece to ensuring patient
safety. In addition to this, Nurse Informatists may also be responsible for training staff to
use BCMA systems in practice. Awareness of how satisfaction predicts workaround
usage is necessary to ensure they continuously monitor staff for levels of satisfaction with
the new system, both prior and post implementation.

5.16.3 Implications for nursing education
Findings from this study can assist nurse educators to fulfill the recommendations
from the Quality and Safety Education for Nurses (QSEN) initiative (Cronenwett et al.,
2007). In order to ensure competence in medication administration, nurse educators
should integrate BCMA practices into their curricula in order to provide the proper
knowledge, develop appropriate skills, and expose student nurses to the attitude that
BCMA satisfaction is necessary to reduce the use of workarounds. Student nurses should
learn the dangers of utilizing workarounds during medication administration and that
satisfaction with BCMA systems impacts their use. By teaching students to use BCMA
from their very first experience with medication administration, students may be less
likely fall victim to utilizing manual medication administration strategies because they
will never have known them. Providing students with the opportunity to practice the skill
of BCMA in the laboratory setting will allow them to become confident and avoid
computer anxiety related to this skill if they are inexperienced using computers. Most
importantly, teaching students and modeling the attitude that proper BCMA use is the
only acceptable method for safe medication administration will develop students who
will enter the practice setting prepared to accept nothing but BCMA systems which
promote safe practice, rather than inhibiting it through poor satisfaction and high workaround usage.

Nurse educators specializing in professional development will also benefit from findings of this study. In some instances, these educators may oversee orientation or staff training and inservice for BCMA systems. Understanding the user characteristics which are associated with satisfaction levels and workaround usage can guide nurse educators to develop BCMA education programs. Knowing that nurse satisfaction with the system impacts workaround usage, educators may work to ensure nurses are satisfied with the BCMA system and all of its components. They should also be on alert for issues which result in low levels of satisfaction because this may indicate that workarounds are being utilized more frequently than when satisfaction levels are high. Workaround usage can result in greater risk to patients in the form of medication errors. Nurses are often sensitive to discussing medication administration errors, but approaching the subject by first discussing nurse satisfaction with the system may provide educators with a segway to broach the subject. It is also important for educators to help staff to understand the usefulness of BCMA systems and ensure competency with scanning so nurses’ perceptions of ease of use will be positive. Poor scanning technique may lead nurses to perceive that a system is not useful if they can’t make the system work as they need it to, which could set them up for a higher rate of workaround usage.

5.16.4 Implications for Nurse Administrators

With the push from the United States Government for hospitals to comply with Meaningful Use guidelines, Nurse Administrators hold a vested interest in the outcomes of this study (Bigalke & Morris, 2010). Reimbursement dollars are dependent on
successful integration of health information technology into acute care settings. In order for a successful and safe integration into practice, nurse administrators hold the ultimate accountability for nurse satisfaction with the BCMA system. They are in a position to ensure that they have the right team who will create a system that is satisfactory to their nurses. They must also insist that nurse managers monitor bedside satisfaction levels with the hospital’s system in order to reduce the number of medication administration errors. When nurses are dissatisfied with the system, direct communication of this information to nurse administrators is imperative so issues of concern/dissatisfaction can be addressed and resolved. Nurse administrators must remember that nurse satisfaction with BCMA is a predictor of workaround usage. BCMA satisfaction may be used as an indirect, yet accurate and less threatening way to understand medication administration errors in the hospital.

For hospitals seeking to obtain or maintain Magnet® recognition, general levels of nurse satisfaction, as well as nurse administrator advocacy for bedside nurses, are important contributions to this endeavor. Nurse administrators who address nurse dissatisfaction with BCMA systems will not only improve patient safety, but may also have an impact over levels of nurse satisfaction, which demonstrates their ability to advocate for the needs of the bedside nurse. Validation of such impact and advocacy are behaviors in which the American Nurses Credentialing Center looks for in lead nurse administrators at Magnet® organizations.

Lastly, nurse administrators should keep in mind that nurses in this study with 26-30 years of experience had the lowest levels of BCMA satisfaction and the highest level of workaround usage. While this study did not seek to understand the rationale behind this,
it may be useful to monitor the practices of these nurses more closely. Due to their high satisfaction scores and low workaround usages, nurses with fewer than 10 years of experience may serve as role models, preceptors to new employees on the unit, or super users/champions to ensure nurses are properly instructed on BCMA techniques.

5.17 Recommendations for future research

The phenomena of BCMA satisfaction and workaround usage are still new topics and pose many opportunities for future research. Future research is needed to not only understand the relationship of these variables to each other, but to also understand them individually. The variables of PU and PEOU, as they related to both study variables, are virtually untouched topics in nursing and information technology.

Research aimed to develop profiles of nurses who are both satisfied and dissatisfied with BCMA may also be useful. Nurses possessing the characteristics of those who tend to be satisfied with BCMA systems may be sought out as champions for introducing BCMA to practice. Understanding the profile of nurse who tend to be dissatisfied with BCMA systems allows nurse administrators and educators to strategically plan patient safety and quality initiatives for this group of people. Developing such profiles may be done by using the WUSBIN to measure BCMA satisfaction, workaround usage and study subject demographics.

Future research is indicated to evaluate the degree to which improving satisfaction actually reduces workaround usage among nurses. This research should further evaluate the relationship between satisfaction and workaround usage, as well as satisfaction and the number and type of workarounds used. Additional attention is warranted to the relationship between BCMA Satisfaction and PEOU and PU.
Investigating how improved satisfaction/reduced workaround usage impacts patient safety should also be pursued. Successful measures of this relationship may include reduced medication administration error rates and adverse drug events.

Further testing of the *WUSBIN* in larger and more diverse populations is also indicated to ensure generalizability of the instrument. It may also allow for better representation of nurses from all clinical areas. Since this study showed some significant relationships between years of experience and *BCMA Satisfaction*, future research is needed to understand how experience levels impact satisfaction with BCMA systems could yield useful results. Lastly, further investigation how to best measure *PU* and *PEOU* will also be helpful in understanding how these variables impact *BCMA satisfaction* and *workaround usage*.

5.18 Summary

This chapter presents a discussion of the findings of this study, including the descriptive findings and the exploratory analysis outcomes. Further discussion addresses implications for nursing and recommendations for future research. While there are many factors which impact patient safety and quality of care, nurses’ involvement in keeping patients safe remains among one of the greatest defenses available. The use of technology in healthcare will continue to grow and improve over time. Nurses have a direct responsibility to ensure that this occurs. Medication administration is a major role for nurses practicing in the acute care setting. It is impossible for growth in this area to occur without the direct input of nurses. The usage of workarounds will likely remain a sensitive topic for nurses to discuss and admit. Using the variable of BCMA Satisfaction
to measure workaround usage is a reliable resource to improve technology and ensure patient safety related to medication administration.
References


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Appendix A
Your Input is Needed!

You’re invited to complete

The BCMA Survey

The purpose of this study is to determine the relationship between nurse satisfaction with barcoding while passing medications (BCMA-barcoding medication administration) and the use of workarounds (alternate routes to passing medications to patients)

See your email for a link to this online survey or contact the Investigator to complete the survey on paper

Questions? Contact, Sally Bennett, MS, RN

PhD in Nursing Candidate at
Duquesne University School of Nursing

This research study is part of a doctoral dissertation of the Investigator
Appendix B
Dear Registered Nurse,

This email is sent to you because you may meet inclusion criteria to participate in a nursing research study. It has already been determined that you are a registered nurse working on a nursing unit which qualifies for the study. In order to qualify for this study, you must have worked on a nursing for at least six months, where barcoding is utilized to administer medications. If you meet this criteria, you are invited to take part in a nursing research study that seeks to understand the relationship between nurse satisfaction with barcoding medication administration (BCMA) and the use of workarounds, or alternate routes to medication administration. This study is part of my doctoral dissertation project. The survey will take approximately 20 minutes of your time and is completely anonymous. There is no way to connect your name to the answers you provide in the survey. The survey may be accessed on SurveyMonkey.com, a secure professional, commercial website that is designed to conduct online surveys to collect anonymous data for various purposes, including research studies. It has a secure server with 128 bit encryption. This online survey uploaded there will not collect any identification information of the participants. The researcher will keep all data secure and confidential. All data will be stored in a locked file cabinet for 5 years in the office of the researcher where no other people have access to except myself and my advisor. To access this survey, simply click on the link at the end of this email, which will take you directly to the survey. The survey will be available until January 21, 2012.

In order to ensure the integrity of the study data, it is important that you do not complete this survey more than once or if you do not qualify to complete it.

For more information about this survey, please access the survey for complete directions. If you prefer to complete this survey on paper instead of electronically, please contact me, by replying to this email or calling me directly. If you have any questions about the study, you may contact Sally Bennett at 887-4530, Dr. Joan Lockhart, Advisor, at 412-396-6540, Dr. Joseph Kush, Chair of Duquesne University Institutional Review Board at, 412-396-6326 or Dr. Ferrol Lee, Chair of the Guthrie Healthcare Institutional Review Board at 887-4885.

Sincerely,

Sally Bennett, MS, RN

PhD in Nursing Candidate, Duquesne University School of Nursing

http://www.surveymonkey.com/s/WUSBINsurvey
Appendix C
Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN)

The purpose of this survey is to measure whether there is a correlation (or relationship) between nurse satisfaction with barcoding medication administration (BCMA) and the use of workarounds in order to get work done. There are three parts to this survey. Each part begins with a brief set of instructions. There is no right or wrong answers to this survey, so it is important that you answer each item honestly. By completing this survey, you are indicating consent to participate in this evaluation. There is no way to link your identity to the answer you are providing. The survey will take approximately 20 minutes to complete. Since this survey is available in a paper format or electronically, please only complete the survey once. If you prefer a different format than the one offered here, please contact the study’s Principal Investigator, Sally Bennett at x 4530. Thank you for taking the time to complete this survey and for providing your opinion.

Part I

This part of the survey is interested in your opinion. Question 1 asks you to rate your overall satisfaction with the current barcoding medication administration system. The following statements describe experiences and beliefs about the current medication administration system you use. By current medication administration system, we mean the institutional structures and operational policies that direct and support the process and procedures of delivering/administering pharmaceutical products to patients. This includes all medication administration activities and documentation, as well as the technologies associated with the current medication system, such as barcoding scanners, that are required in the process of getting medications to patients. There are also questions which ask you more specifically about your personal barcoding medication administration practices. Please read each statement (2-47) and indicate the number that best expresses your own experiences and beliefs. Please indicate the degree to which you agree or disagree with each item by using the following RATING SCALE

1 if you strongly agree with the statement.

2 if you moderately agree with the statement.

3 if you slightly agree with the statement.

4 if you slightly disagree with the statement.

5 if you moderately disagree with the statement.

6 if you strongly disagree with the statement.

NA if the statement does not apply to you.
Questions 48-49 are multiple choice style.

1. Overall, how satisfied are you with the current medication administration barcoding system? Please choose a number between 1-10, with 1 = complete dissatisfaction and 10 = complete satisfaction.

**Nursing Satisfaction Subscale—Efficiency**

2. The current medication administration barcoding system helps me to be efficient at medication administration.
3. The current medication administration system is user-friendly to the nurses who administer medications.
4. The equipment or supplies needed to administer medications are readily available to me.
5. The current medication administration barcoding system is effective in reducing and preventing medication errors.
6. The turnaround time for receiving medications needed for “stat” of for patients newly admitted to the unit is adequate.

**Nursing Satisfaction Subscale—Safety**

7. When I see a message that acknowledges and accepts a known drug-drug interaction, I know that both physician and pharmacists communicated and agreed on the order.
8. The current medication administration system makes it easy to check active medication orders before administering medications.
9. I find the drug alert feature (drug-drug or drug-food interaction) of the current medication administration system helpful.
10. The current medication administration system provides me with information to know that a medication order has been checked by a pharmacist before I administer the medication.
11. The current medication administration barcoding system makes it easy to check that I am following the “5 rights” when I administer medications.
12. The current medication administration system promotes two-way communication between clinicians (MD, pharmacist, RN) about medication orders.
13. I am apprehensive about the barcoding medication system and do not like using it to administer medications.
Nursing Satisfaction Subscale—Access

14. The drug information available through the current medication administration system is easy to get when I need that information.
15. Information available through the current medication administration system helps me to know what to do should my patient have any bad reactions from a medication.
16. Because of information available through the current medication administration system, I know both the intended actions and side effects of medications I administer.
17. I have access to the systems that support medication administration (physicians’ orders, drug information) when I need them.
18. I know where all the medications I need are stored (either on the unit or if they need to procured from the pharmacy).
19. If I have a problem with the barcoding scanners, I can call the Help Desk to get the scanner fixed or replaced in a timely manner.

Workaround Subscale—Block Perceptions

20. Problems with barcoding prevent me from completing tasks as well as I would like to.
21. Problems with scanners prevent me from completing tasks as well as I would like to.
22. Rules or policies prevent me from passing medications as well as I would like to.
23. Other people prevent me from passing medications as well as I would like to.
24. Poorly designed work processes prevent me from passing medications as I would like to.

Workaround Subscale—Altering Processes

25. I have to alter my work process because of problems with barcoding.
26. I have to alter my work process because of problems with scanning.
27. I have to alter my work process because rules or policies keep me from passing medications efficiently.
28. I have to alter my work process because other people keep me from passing medications efficiently.
29. I have to alter my work process because my work process to pass medications are not well designed.
Workaround Subscale—Procedural Preferences

30. When possible, I follow procedures regarding the use of technology when it comes to passing medications
31. When possible, I follow procedures regarding the use of scanners
32. When possible, I follow rules and policies at work related to medication administration
33. When possible, I follow intended work processes for medication administration, even when they are poorly designed
34. When given the choice between following procedures related to medication administration or taking a shortcut when passing medications, I prefer to follow procedures
35. I generally take shortcuts during medication administration when I can
36. I’ve figured out the easiest ways to complete my work, even if it means not following procedures related to medication administration

Workaround Subscale—Motive to Assist Patients

37. If I have to alter my work process because of problems with barcoding, I do so to better assist a patient
38. If I have to alter my work process because of problems with scanners, I do so to better assist a patient
39. If I have to alter my work process because of rules or policies related to medication administration, I do so to better assist a patient
40. If I have to alter my work process because other people keep me from doing my job, related to medication administration, I do so to better assist a patient
41. If I have to alter my work process because my work processes related to medication administration are not well designed, I do so to better assist a patient

Workaround Subscale—Computer Anxiety

42. I alter my work process with barcoding because I do not trust the system
43. I alter my work process with barcoding because I am afraid that the scanners do not work properly
44. I alter my work process when passing medications with barcoding because the rules or policies make me feel uneasy and/or uncomfortable
45. I alter my work process with barcoding because I fear making mistakes I cannot correct
46. I alter my work process when passing medications using a barcoding system because I feel intimidated and threatened by the system
47. I feel apprehensive about passing medications using a barcoding system
Workaround Subscale—Workaround Types

48. While using a BCMA system, have you ever (choose all that apply)
   a. Scanned a medication from a patient drawer without a visual check of the e-Mar, medication name or dose
   b. Administered a medication without reviewing parameters for administration
   c. Reviewed a medication requiring a double check administered by another nurse without actually reviewing the medication
   d. Administered a new medication before verifying the new medication order
   e. Administered a medication to a patient without scanning their ID band
   f. Administered a medication without scanning the medication barcode
   g. Documented a medication administration before the medication is actually given to the patient/or observed the patient ingest it
   h. Scanned a patient ID code from another object not on the patient
   i. Prepared, scanned and transported medications for more than one patient at a time
   j. Scanned the medication barcode after the barcode label has been removed from the medication itself
   k. Scanned the same package multiple times when multiple packages of medication are required for the full dose
   l. Taken the scanner into the patient room and left the CAB outside the room where you cannot see it
   m. Given a partial dose of a medication but documented that the entire dose was given

49. Which of the following would you say you do the most often (choose only ONE)?
   a. Scanned a medication from a patient drawer without a visual check of the e-Mar, medication name or dose
   b. Administered a medication without reviewing parameters for administration
   c. Reviewed a medication requiring a double check administered by another nurse without actually reviewing the medication
   d. Administered a new medication before verifying the new medication order
   e. Administered a medication to a patient without scanning their ID band
   f. Administered a medication without scanning the medication barcode
   g. Documented a medication administration before the medication is actually given to the patient/or observed the patient ingest it
h. Scanned a patient ID code from another object not on the patient
i. Prepared, scanned and transported medications for more than one patient at a time
j. Scanned the medication barcode after the barcode label has been removed from the medication itself
k. Scanned the same package multiple times when multiple packages of medication are required for the full dose
l. Taken the scanner into the patient room and left the CAB outside the room where you cannot see it
m. Given a partial dose of a medication but documented that the entire dose was given

Part II

Questions 50-51 are open-ended questions. Please type your response.

50. Please add any comments you wish about the current medication administration barcoding system and the degree to which components of the current barcoding system support your ability to administer medications safely and professionally.

51. If you could change one thing in the current medication administration barcoding system, what would it be?

Part III

Questions 52-63 ask questions about your age, gender, employment status and history and computer usage and skill. Please choose the appropriate choice.

52. What is your gender?
   a. Male
   b. Female

53. What is your age?
   a. <20 years old
   b. 21-30 years old
   c. 31-40 years old
   d. 41-50 years old
   e. 51-60 years old
   f. 61-70 years old

54. Highest nursing degree
   a. Diploma
   b. AS/AD
   c. BS/BSN
   d. MS/MSN
   e. PhD

55. Number of years employed as a nurse
   a. <2 years
b.  2-5 years
   c.  6-10 years
   d.  11-15 years
   e.  16-20 years
   f.  21-25 years
   g.  26-30 years
   h.  31-35 years
   i.  36+ years
56. Number of years employed at Robert Packer Hospital as an RN
   a.  < 2 years
   b.  2-5 years
   c.  6-10 years
   d.  11-15 years
   e.  16-20 years
   f.  21-25 years
   g.  26-30 years
   h.  31-35 years
   i.  36+ years
57. Which type of unit do you work on?
   a. Primarily Inpatient
   b. Primarily Outpatient
58. What is your employment status?
   a. Full Time (includes weekend option)
   b. Part Time
   c. Per Diem
59. Typical shift rotation schedule
   a. All shifts
   b. All days
   c. All evenings
   d. All nights
   e. Rotate days/eves
   f. Rotate days/nights
   g. Rotate eves/nights
60. Typical weekly schedule
   a. Mostly weekends/holidays
   b. Mostly Monday-Friday
   c. Rotate weekdays/weekends/holidays
61. Compared to your nursing peers, how do you rate your computer skills?
   a. Above average
   b. Average
   c. Below average
62. Do you use a computer at home?
   a. Yes
   b. No
63. How do you rate your skills at obtaining patient information from the RPH computer system (EPIC)?
a. Excellent
b. Good
c. Fair
d. Poor
Appendix D
Hi Sally

Attached are the MAS-NAS forms. Please use as you see fit & best wishes. No fee. I hope this works out for you.

Ann
Sally,

You have my permission to use and modify the Workaround Assessment as needed for your dissertation.

Best Wishes,
Jonathon

Jonathon R. B. Halbesleben, Ph.D.
HealthSouth Chair of Health Care Management & Associate Professor
Department of Management & Marketing
Culverhouse College of Commerce and Business Administration
University of Alabama
Permission to use Technology Acceptance Model Schematic from Dr. Fred Davis

Fred Davis [FDavis@walton.uark.edu]

To: Sally Bennett
Monday, June 27, 2011 8:30 AM

Sally,
You have my permission to use the model representation as long as you cite the article in your dissertation manuscript.
Best wishes,
Fred Davis
Appendix E
November 7, 2011

Re: The Relationship Between Barcode Medication Administration Satisfaction and the Use of Workarounds Among Nurses – (PROTOCOL # 11-121)

Dr. Joan Such Lockhart  
School of Nursing  
Duquesne University  
Pittsburgh PA 15282

Dear Dr. Lockhart,

Thank you for submitting the research proposal of you and your student Ms. Sally Bennett to the Duquesne University Institutional Review Board.

Based on the review of IRB representative, Dr. Linda Goodfellow, and my own review, I have determined that your research proposal is consistent with the requirements of the appropriate sections of the 45-Codes of Federal Regulations-46, known as the federal Common Rule. The intended research poses no greater than minimal risk to human subjects. Consequently, the research is approved under 45CFR46.101 and 46.111 on an expedited basis under 45CFR46.110.

The approval pertains to the submitted protocol. If you or Ms. Bennett wish to make changes to the research, you must first submit an amendment and receive approval from this office. In addition, if any unanticipated problems arise in reference to human subjects, you should notify the IRB chair before proceeding. In all correspondence, please refer to the protocol number shown after the title above.

Once the study is complete, please provide our office with a short summary (one page) of your results for our records.

Thank you for contributing to Duquesne’s research endeavors.

Sincerely yours,

Joseph C. Kush, Ph.D.

C: Dr. Such Lockhart  
Dr. Linda Goodfellow; IRB Records
August 15, 2011

Sally Bennett, MS, RN
Robert Packer Hospital
Nursing Department
Sayre, PA 18840

Re: IRB # 1108-39 THE RELATIONSHIP BETWEEN BARCODE MEDICATION ADMINISTRATION SATISFACTION AND THE USE OF WORKAROUNDS AMONG NURSES

Dear Ms. Bennett,

This constitutes official notice that the Guthrie Healthcare System (GHS) Institutional Review Board (IRB) reviewed the above-referenced study and determined that it is exempt from IRB based on the following category:

45CFR46.101(b) Category 2
(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

This determination of exemption only applies to the research study as submitted to the IRB and you are expected to follow the protocol as outlined. If you make any changes to the protocol, you must submit an amendment form.

The GHS IRB is registered with the Department of Health and Human Services, operates under the guidelines of Office of Human Research Protection (OHRP) and complies with Federal Regulations 45CFR46.

If you have any questions, please call me or Elaine Wall, IRB coordinator, at extension 4885.

Sincerely,

Ferrol J. Lee, M.D., MBA, FACP
Chairman, Institutional Review Board

www.guthrie.org
Re: The Relationship Between Barcode Medication Administration Satisfaction and the Use of Workarounds Among Nurses – (PROTOCOL # 11-121)

Dr. Joan Such Lockhart
School of Nursing
Duquesne University
Pittsburgh PA 15282

Dear Dr. Such Lockhart,

Thank you for submitting the amendment to Protocol #11-121 to the Institutional Review Board at Duquesne University.

You propose to make minor changes with regard to two aspects of your study: changing your study instrument and the recruitment email. The changes are consonant with procedures and documents originally approved by the IRB and pose no foreseeable risks to subjects or potential subjects.

The research remains subject to all stipulations put forth in this IRB’s original approval letter and annual review remains on the cycle determined by the original approval. The protocol number is shown above. Please use it in correspondence with our office.

The amended consent form is attached, stamped with current approval date but original expiration date. You should use the amended stamped form as original for copies that he distributes or displays.

Thank you for contributing to Duquesne’s research endeavors.

Sincerely yours,

Joseph C. Kush, Ph.D.

C: Dr. Linda Goodfellow
IRB #1108-39 - THE RELATIONSHIP BETWEEN BARCODE MEDICATION ADMINISTRATION SATISFACTION AND THE USE OF WORKAROUNDS AMONG NURSES

Amendment/Communication: It is my plan to begin data collection for the main study on Dec 21, pending Guthrie IRB approval of this amendment.

<table>
<thead>
<tr>
<th>IV. Disposition of Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receipt Acknowledged (No signature required.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disposition of Amendment (to be completed by IRB Chair or Designee)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved by Expedited Review per 45CFR46.110(b)(2): minor changes in previously approved research during the period (of one year or less) for which approval is authorized. To be reported to the IRB at the next convened meeting.</td>
</tr>
<tr>
<td>If Revised, Consent must be signed by future enrollees AND (check all that apply)</td>
</tr>
<tr>
<td>__ Current enrollees in active treatment</td>
</tr>
<tr>
<td>__ Current enrollees in follow-up</td>
</tr>
<tr>
<td>Time frame for obtaining re-consent from current enrollees:</td>
</tr>
<tr>
<td>N/A Next visit or within 90 days Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After review at a Convened Meeting, this application was:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deferred (see letter to investigator)</td>
</tr>
<tr>
<td>__ Not approved (see letter to investigator)</td>
</tr>
<tr>
<td>__ Approved, no modifications required</td>
</tr>
<tr>
<td>__ Approved, subject to minor changes to be reviewed by IRB Chair or designee.</td>
</tr>
<tr>
<td>If Revised, Consent must be signed by future enrollees AND (check all that apply)</td>
</tr>
<tr>
<td>__ Current enrollees in active treatment</td>
</tr>
<tr>
<td>__ Current enrollees in follow-up</td>
</tr>
<tr>
<td>Time frame for obtaining re-consent from current enrollees:</td>
</tr>
<tr>
<td>N/A Next visit or within 90 days Other</td>
</tr>
</tbody>
</table>

Conflict of Interest statement: I do not have a personal, scientific or financial interest in this research.

Signature of IRB Chair or Designee

[Signature]

Date

12/15/11

No signature is required for receipt acknowledgement.
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE: The relationship between barcode medication administration (BCMA) satisfaction and the use of workarounds among nurses: A pilot study

INVESTIGATOR: Sally F. Bennett, MS, RN, PhD Candidate
Duquesne University School of Nursing
983 Walker Hill Road
Waverly, NY 14892
607-565-4928

ADVISOR: (if applicable:) Dr. Joan Such-Lockhart
Professor DUSON
542C Fisher Hall
Pittsburgh, PA 15282
412-396-6540

SOURCE OF SUPPORT: This pilot study is being performed as partial fulfillment of the requirements for the doctoral degree in Nursing at Duquesne University.

PURPOSE: You have been selected to participate in a pilot study for a nursing research study which seeks to understand the relationship between nurse satisfaction with barcoding medication administration (BCMA) and the use of workarounds, or alternate routes to medication administration. This pilot study will test the survey known as the Workaround Usage and Satisfaction with Barcoding Instrument for Nurses (WUSBIN). This instrument measures the relationship between nurse satisfaction with
BCMA systems and workarounds utilized by nurses during medication administration. This is a new survey which consists of two previously developed surveys which have been merged into one instrument. The purpose of this pilot study is to test the survey from the above mentioned study to determine how they survey works by testing if the wording of survey items is clear, if the survey flows smoothly and to measure the amount of time it takes to complete the survey. If you agree to participate, you will be asked to complete the survey on a computer utilizing a web-based program known as Survey Monkey, a secure professional, commercial website that is designed to conduct online surveys to collect anonymous data for various purposes, including research studies. It has a secure server with 128 bit encryption. This online survey will not be uploaded there will not collect any identification information of the participants. If you are not comfortable completing the survey using Survey Monkey, you may take the survey on paper. In order for me to determine how the survey works and to measure the amount of time it takes for you to complete the survey, it is necessary for me to sit in the same room as you as you complete the survey. I will encourage you to speak your thoughts out loud as you complete the survey and to also point out to me anything within the survey that is not clear, that you do not understand, or that does not work or flow smoothly. I will also time how long it takes you to complete the survey. Since the purpose of this pilot test is to test the study survey, your responses will not be included in the analysis of the study data; therefore, it will be discarded as soon as the pilot study is complete—approximately two to four weeks. I will not record any personal information which could identify you. Since your participation in the pilot study is confidential and your responses to the survey will be discarded, you will be eligible to participate in the primary study.
when it is made available to the nursing staff at the hospital.

You are being asked to participate in this study because you are a registered nurse who uses BCMA to administer medications to patients. Your participation requires completion of a 63 question survey. It is anticipated that 10 nurses will complete this pilot study at Robert Packer Hospital.

**RISKS AND BENEFITS:** There are no risks greater than those encountered in everyday life for participating this pilot study. There are no direct benefits to you participating in this pilot study, but the knowledge gained from this study may be used to improve the WUSBIN survey before it is administered to other nurses.

**COMPENSATION:** There is no compensation available to you for participation in this study. However, participation in the project will require no monetary cost to you.

**CONFIDENTIALITY:** Your name will never appear on any survey or research instruments. Your response(s) will be discarded and not utilized for data analysis, as described above. The only information which will be recorded is the length of time it takes you to complete the survey, the type of survey you completed and any feedback or comments you make about the survey during survey completion or immediately after you finish the survey. All materials will be destroyed at the completion of the research. Your participation in this study will not be reported to anyone who is employed within the Guthrie Healthcare System.

**RIGHT TO WITHDRAW:** You are under no obligation to participate in this pilot study. You are free to withdraw from this study at any time before survey submission. Once your survey is submitted, it cannot be retrieved.
because there are no identifiers attached to it. Not participating in this study will not put your job in jeopardy or impact your employment status in any manner.

SUMMARY OF RESULTS: A summary of the results of this pilot may be supplied to you, at no cost, upon request.

VOLUNTARY CONSENT: I have read the above statements and understand what is being requested of me. I also understand that my participation is voluntary and that I am free to withdraw my consent at any time, for any reason. On these terms, I certify that I am willing to participate in this research project.

I understand that should I have any further questions about my participation in this study, I may call Sally Bennett, Principle Investigator (x4530), Dr. Joan Such-Lockhart, the Advisor (412-396-6540), Dr. Joseph Kush, Chair of the Duquesne University Institutional Review Board (412-396-6326) or Dr. Ferrol Lee, Chair of the Guthrie Healthcare Institutional Review Board (x4885).
**Research Participant**

Your participation in this research is voluntary. You are not giving up any legal rights by signing this form. You will receive a copy of this form.

By signing below, I certify that I have read or had read to me, and understand this consent form. I have had an opportunity to ask the doctor all my questions concerning the research study, the risks, benefits, alternatives, and risks of those alternatives.

**I consent to participate in the research described in this form.**

Name of Subject: ______________________________________________________

Signature of Subject ________________________ Date: ________ Time: ________

**Person Obtaining Consent**

The subject is not receiving experimental treatments or is in follow-up phase of protocol.

**Person obtaining consent does not have to be a physician.**

I hereby certify that the risks, benefits, alternatives and risks of those alternatives of this study in this consent form have been discussed with the individual granting consent. It is my opinion that the person signing this consent form understands and comprehends all of the matters discussed.

Name of Person Obtaining Consent: ______________________________________

Signature: ________________________________ Date: ________ Time: ________

**Witness (Guthrie Employee)**

The subject has read this form or had it read to him/her. ☐ Yes ☐ No

The subject expresses understanding of this form. ☐ Yes ☐ No

The subject has no further questions. ☐ Yes ☐ No

Name of Witness: ______________________________________________________

Signature: ________________________________ Date: ________ Time: ________
Appendix G
Reminder e-mail

Dear Registered Nurse,

This e-mail serves as reminder that there are still two weeks left for you to complete the survey interested in understanding your barcoding practices. This study is part of my doctoral dissertation project. The survey will take approximately 20 minutes of your time and is completely anonymous. There is no way to connect your name to the answers you provide in the survey. To access this survey, simply click on the link at the end of this email, which will take you directly to the survey. The survey will be available until January 21, 2012.

If you are interested in completing the survey, but do not wish to complete it online, a paper version of the study is now available. You may find the paper version on your unit, in your break and/or report room, with an attached envelope so you may return the completed survey back to me via interoffice mail. In order to ensure the integrity of the study data, it is important that you do not complete this survey more than once.

For more information about this survey, please access the survey for complete directions. For other questions or obtain a paper copy of the survey, please contact me, the principal investigator by replying to this email or calling me at x 4530. If you have any questions about the study, you may contact Sally Bennett, 887-4530, Dr. Joan Lockhart, Advisor, at 412-396-6540 or Dr. Joseph Kush, Chair of Duquesne University Institutional Review Board at, 412-396-6326 or Dr. Ferrol Lee, Chair of the Guthrie Healthcare Institutional Review Board at 887-4885.

Sincerely,

Sally Bennett, MS, RN

PhD in Nursing Candidate, Duquesne University School of Nursing

http://www.surveymonkey.com/s/WUSBINsurvey
Appendix H
<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recruitment e-mail</strong></td>
<td></td>
</tr>
<tr>
<td>Study inclusion criteria omitted</td>
<td>Statements added to beginning of Recruitment email to explain study inclusion criteria. Partial statement added at the end to remind reader they must qualify for the study in order to complete the survey</td>
</tr>
<tr>
<td>Unknown survey completion time</td>
<td>Completion time determined during pilot and inserted in designate spot in email</td>
</tr>
<tr>
<td>Unknown survey end date</td>
<td>Survey end date determined and inserted into designated spot in email</td>
</tr>
<tr>
<td><strong>WUSBIN Survey</strong></td>
<td></td>
</tr>
<tr>
<td>Study inclusion criteria omitted</td>
<td>Statement added near end of first paragraph to clarify inclusion criteria (p 1).</td>
</tr>
<tr>
<td>Unknown survey completion time</td>
<td>Completion time determined during pilot and inserted in designate spot (p 1).</td>
</tr>
<tr>
<td>Last paragraph written in first person</td>
<td>Verbiage changed to third person (p 1).</td>
</tr>
<tr>
<td>No mention of the fact that once you leave the survey, you may not reaccesses it, even if is incomplete</td>
<td>Statement added to clarity (p 2)</td>
</tr>
<tr>
<td>Occasional confusion of pilot participants regarding what certain terms referred to. These terms were identified in the instructions, but some pilot participants forgot they had read them</td>
<td>Statement added just before terms are defined to read the information carefully (p 2). Key phrase put in quotes (p4).</td>
</tr>
<tr>
<td>Likert-type scale defined in instructions—some pilot participants thought they had</td>
<td>Statement added at end of instructions to inform participant that the scale definitions are available with each survey item (p4).</td>
</tr>
<tr>
<td>To remember the scale before proceeding to the survey items</td>
<td>While all nurses should know these, the 5 rights were written out to be absolutely sure participants were thinking of the correct rights and answering the item from the same perspective (p.6).</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Survey Item 11 refers to the 5 rights of medication administration, but they are not written out</td>
<td>Nurse Satisfaction Subscale: Access Several pilot participants were confused regarding the meaning of “Drug Information”. A clarification statement was added to appear at the beginning of the subscale items in the survey (p.7).</td>
</tr>
<tr>
<td>Items 22, 27 and 44 were questioned by pilot participants because these items did not specify that the policies referred to in the statement were specific to medication administration</td>
<td>Items 22, 27 and 44 were questioned by pilot participants because these items did not specify that the policies referred to in the statement were specific to medication administration. Other statements (i.e., item 32, 39) were asking about the same policies and specifically stated “related to medication administration”. This phrase added to items 22, 27 and 44 for consistency and clarity (pp. 8, 9, 12).</td>
</tr>
<tr>
<td>Statements within the Subscales “Altering Processes” and “Motive to Assist Patients” were noted by several pilot participants to be unclear. They were not exactly sure what ‘work processes’ referred to</td>
<td>A clarification statement was added to appear at the beginning of the subscale items in the survey (pp. 9-11).</td>
</tr>
<tr>
<td>Item 48 &amp; 49 had several suggestions to improve clarity</td>
<td>Instructions expanded to inform participant options for each question are the same. This was done because the lists are long and there is a lot of information to keep track of (p. 13) 3rd choice—examples provided (p. 13) 5th and 6th choices do not include failed scanning attempts—several participants asked to have this point clarified during the pilot (p. 13) Question 49 emphasized the word “most” for clarity</td>
</tr>
<tr>
<td>Instructions to items 50 and 51 do not state whether it’s acceptable to leave the comment box empty, or if participants must write in ‘n/a’</td>
<td>Statement added that it is acceptable to leave comment boxes blank (p. 14)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Item 55 and 56—first two options are not meaningful as written</td>
<td>Since the BCMA system was implemented in the study hospital 4 years ago, it makes more sense to count the number of nurses who have never administered medications in the paper world (worked &lt; 4 years), and to count those who came in during the transition (worked 4-5 years), since the transitional period from paper to computer can have a large number of workarounds. If the preceptors training nurses who were hired in that timeframe were unsure of the new system or were using a lot of workarounds themselves because of the transition, these nurses could have been inappropriately trained to the system, which may have resulted in the development of incorrect medication administration processes (p. 15).</td>
</tr>
</tbody>
</table>